FRACTURES AND ORTHOPAEDIC SURGERY
FOR NURSES AND MASSEUSES

First published 1946

FRACTURES & ORTHOPAEDIC SURGERY FOR NURSES AND MASSEUSES

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FOREWORD

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With 243 Illustrations

E. & S. LIVINGSTONE LTD
16-17 TEVIOT PLACE, EDINBURGH 1
1945

ACKNOWLEDGMENTS

THE Author gratefully acknowledges his indebtedness to the following for use of illustrations

Mr Watson Jones *Fractures and Joint Injuries* (E. & S Livingstone Ltd) Figs 83 95 102 103 108 121 122 124 126 127 and 167

Mr Walter Mercer s *Orthopaedic Surgery* (Edward Arnold & Co) Figs 146 148 155 162 and 185

Pye s Surgical Handicraft edited by Mr Hamilton Bailey (John Wright & Sons) Figs 192 and 193

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PREFACE

As in other fields of medicine and surgery the success of orthopaedic surgery is dependent upon the knowledge skill, and care of the nurses and physiotherapists to whom after-care and treatment is delegated With so much to learn in the time available during training the student nurse has often only a bare minimum of instruction in orthopaedic surgery and is liable to have a restricted view of its scope and methods Yet approximately one-fifth of her surgical work will be concerned with this branch of surgery With the expansion of surgery in general and in orthopaedics ' in particular it is impossible to cover the whole of a special branch of surgery without overburdening a very full curriculum The principles of surgery are the same for general surgery and for its special branches hence the emphasis upon these general principles and general surgery during the training period This book is written with the object of showing the nurse how these principles are applied in orthopaedic surgery and as a supplement to her lectures in surgery It is assumed that these general principles have been assimilated

I trust that this book will be useful to those whose names are already upon the State Register and intend to undertake or are engaged in nursing in orthopaedic wards or at special hospitals, or in the Public Health services I hope that it will be of value to physiotherapists as a general outline of the clinical and surgical aspects of orthopaedic conditions which they often do not see until after treatment is begun It is my earnest desire that I leave my readers with the impression that of the three essentials of treatment prevention of deformity correction of deformity and maintenance of correction the greatest of these is prevention

I have pleasure in acknowledging my indebtedness to all who have helped directly and indirectly in the production of this book

Firstly to Mr F W Goyder for his valuable advice instruction and constructive criticism and for permission to

reproduce photographs of many of his patients I also wish to thank Mr Basil Hughes and Mr G W Watson for permission to use certain photographs of patients under their care My thanks are due to Mr F Dewhurst assisted by Sisters McKenna and Burke and Miss B Munro for the production of the photographs and to Dr D H Blakey and my wife for the production of the line drawings I am deeply indebted to Mrs C L Alderson for her untiring efforts with the preparation of the manuscript I have pleasure in acknowledging the help and suggestions provided by Dr J Douglas who has undertaken the arduous duties of proof reading

I am particularly indebted to Professor E Finch who has been a constant source of inspiration and encouragement to me and has given me a wealth of advice His constructive criticism and suggestions have been invaluable in the compilation of this book

In conclusion I wish to acknowledge the courtesy co-operation and help afforded by Mr C Macmillan of Messrs Livingstone and my unknown critics the Publishers readers

A. NAYLOR

BRADFORD
January 1945

FOREWORD

I will go before thee and make the crooked places straight (ISAIAH xlv 2)

THE orthopaedic surgeon could well preach his sermon from the above text Recently the speciality has come to include not only the "crooked places" the result of disease but also those caused by trauma The orthopaedic and traumatic clinic has become a definite and distinct department of every well-organised hospital Its work is now being extended to its logical conclusion of restoration of function by rehabilitation which should commence the split second after the injury To get the best results the treatment of the case should be in the hands of the same team of surgeons, casualty officers, nurses physiotherapists etc , from the beginning to the end If this is done then the work of an orthopaedic and traumatic clinic plays a great part in attaining the Social Security for which at present all are planning

It is, however a speciality which should not be taken just for its inherent glamour or pity for crippled children The latter would be the first to resent pity , they are usually endowed with acute understanding and application as all who have educated them can testify They do not want "care" but "cure" in so far as the latter means restoration of function The great qualification for inclusion in the team is a sound training in the principles of general surgery and nursing Mr Naylor has written this book to help those who devote themselves to the nursing of traumatic and orthopaedic cases He rightly must assume that they have had a sound training in basic principles but in order to widen their interest in and understanding of the treatment they will find much information here which will be of real help

The term "orthopaedics" was first coined by Nicholas André in 1714 and the first Orthopaedic Institute was founded in 1780 in Switzerland by Venel

In this country William John Little established the Royal Orthopaedic Hospital in 1837 and published his text book on Deformities in 1853

In spite of this early start little progress was made in establishing the speciality until the present century and this is associated with the names of Hugh Owen Thomas and Robert Jones and their band of disciples up and down the country

The progress of orthopaedic and traumatic surgery with its near relation plastic surgery is perhaps one of the few

good things that have emanated from the Great War and the present conflict

Progress in the surgical art is inextricably bound up with warfare The first surgical problem must have been the treatment of a wound as it may well be the last

The problem seemed solved as the result of the Listerian Renaissance Haemorrhage though still a surgical bugbear could be controlled and pain had been in great part eliminated by anaesthesia

Infection was to be prevented by antisepsis and asepsis Medical and Surgical 'nursing' had been established—all seemed well Speed in operative technique had become an accomplishment and no longer an aim The surgical anatomist had made way for the surgical pathologist On 18th November 1895 William Conrad Röentgen (1845–1928) Professor of Physics at Wurzburg had discovered X rays and reported it to the local Medical Society on 28th December 1895

The surgeon was thus provided with vision to see deeper structures visual anatomy was a fact

The surgical pathologist in due course was joined by the surgical physiologist The surgery of Reconstruction and Function was added to that of Incision and Excision

The preservation and restoration of function became recognised as the great aim of surgical intervention The decision when not to operate was becoming as important as its opposite Under these circumstances it was natural that specialisms in surgical procedures should become more numerous

It therefore became more important that the entry to such specialism should be through the portal of general surgery No matter where the wound occurred whether in superficial or deep tissues the basic principles of Rest Conservation of Blood Supply and Prevention of Infection must be applied

No matter what number of drugs may be introduced and whatever their nature may be, the greatest reparative factor the human body possesses is LIFE

The difference between the living and the dead is that the former carries out its own repairs

It is to help nurses and masseuses to understand and follow the principles of orthopaedics that Mr Naylor has written this book and as such it is hoped that they will possess and prize it

ERNEST FINCH

SHEFFIELD,
January 1945

INTRODUCTION

WITH the advance of the surgical art, orthopaedic surgery is rapidly developing into a wide speciality. The term "orthopaedic" is derived from the Greek words ορθος, meaning straight, and παις παιδος, a child, and "orthopaedics" were originally associated with deformities of children. Later in the nineteenth century orthopaedic surgery was concerned with the correction of deformities and diseases of the locomotor system by mechanical means. To-day orthopaedic surgery is that branch of surgery outlined by Sir Robert Jones, viz. the surgery necessary for the repair of the injuries, deformities, and diseases of the locomotor system. This includes the prevention as well as the treatment of the injuries, deformities and diseases of the skeleton, joints, ligaments, cartilage, tendons, bursae, muscles and their nerves by mechanical, manipulative, surgical and re-educative means. It must be emphasised that *prevention* of the development of deformity and disease should play a major part in orthopaedic treatment.

Orthopaedic surgery must be distinguished from cults such as osteopathy and chiropractic surgery. Osteopathy is based upon the theory that structural defects of the body are the predisposing cause of disease, and treatment is directed primarily to the rectification of these by manipulative methods. It must be added, however, that no one has demonstrated the alleged structural defect or subluxation either by radiographs or at post mortem examination.

Chiropractic surgery postulates that displacements of the vertebrae produce pressure upon the nerves and prevent the free flow of the "nerve force" which is essential for the well being of the body. These displacements are corrected by manipulation without anaesthesia. Again radiology and pathology fail to substantiate the presence of the alleged lesions.

While we speak of the speciality as orthopaedic surgery, it should be borne in mind that operative methods comprise only about one third of the treatment. It is important at the

outset that one should realise that orthopaedic conditions involve the body as a whole, and the problem should be viewed from that standpoint Further, one should take a broad view of the affection in question, bearing in mind the effects of treatment over a number of years and not of one isolated incident in the treatment. Operative measures should be regarded as incidents and not as the essential part of a long term plan of treatment whilst attention to minute details is essential and necessary if a successful outcome is to be ensured

A crooked body is apt to be associated with a warped mind because of the relative loneliness and the sense of inferiority felt by these unfortunate people This attitude must be rectified if orthopaedic treatment is to be successful Behaviour depends on emotion and emotional stability is necessary for satisfactory adjustment to life Emotional upsets are often traceable to disturbances in early life, which may be due to a knowledge of being different from other children

When nursing young orthopaedic patients, the nurse must remember that the child may be emotionally unstable because of his physical disability and also because of his removal from home and mother He is likely to be more easily frightened and lonely and the nurse must reassure him and try as nearly as possible to replace his mother He must be constantly encouraged to overcome his physical disability as orthopaedic after treatment depends largely upon the patient s own efforts Some children develop aggressive tendencies as a result of an inferiority complex and these need tactful and very patient handling if this is not to be increased Other children react by developing a negative and sullen attitude which can seriously hamper after treatment especially when muscle re-education is required

On the other hand while a certain degree of spoiling is necessary the patient must not be allowed to become the centre of interest or the object of pity If this occurs the patient is apt to do nothing to help himself to overcome his disability and he becomes absolutely reliant upon others especially when he leaves hospital

The burden of a prolonged stay in hospital can be lightened considerably by the provision of educational facilities and occupational therapy When children who are under orthopaedic supervision leave hospital and commence school it is better that they first attend separate schools set apart for cripples There they are not subject to the taunts of other children devoid of such physical handicaps, and so any tendency to a sense of inferiority is removed Our aim is to equip these children so that they can compete with normal children when they leave school and embark on their careers We can help them to achieve this only by constant observation and correction of the many psychological factors in their make-up in addition to amelioration of their physical deformities and disabilities

With adult patients suffering from fractures and orthopaedic disabilities it is just as important for the surgeon nurse and masseuse to treat them psychologically as well as surgically They should be imbued with the desire to get well by constant encouragement from their medical attendants While surgical treatment is progressing the patient should be gradually brought to a fit condition to resume his former work by a series of exercises and occupational therapy By close co-operation between employers and the surgical team through the offices of an almoner and other welfare organisations, the patient should be allowed to engage in some form of work before he is really fit to perform his normal occupation This gives him confidence in the use of his injured limbs Those who will never be fit to return to their previous employment need training for new occupations (vocational training) These processes are collectively known as rehabilitation Rehabilitation is not a new form of treatment to be practised by rehabilitation specialists It is the mechanism of placing the patient in a position to pursue his former or equivalent occupation by means of surgery nursing physical and psychological treatment and requires co-operation between surgeon nurse masseuse patient and employer

A NAYLOR

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CHAPTER I

ORTHOPAEDIC APPARATUS

THE correct use of orthopaedic apparatus is just as essential to the success of orthopaedic treatment as well-executed operative measures It serves the following purposes

1 To prevent deformity
2 To correct deformity
3 To maintain position and enforce rest
4 To restore function by gradual encouragement of movement of joints

The apparatus employed in the treatment of orthopaedic conditions consists of plaster of Paris casts, braces splints and traction devices

Despite the advances made in medicine and surgery, one finds that the principles and often practice, of fracture and orthopaedic treatment are the same to day as were used many centuries ago

Hippocrates (460–377 B C) in his writings gives explicit instructions concerning the treatment of fractures, and advocates the use of methods which are modern " to-day For the treatment of a fractured humerus he says Having got a piece of wood a cubit or somewhat less in length, like the handles of spades suspend it by means of a chain fastened to its extremities at both ends and having seated the man on some high object the arm is to be brought over so that the armpit may rest on the piece of wood and the man can scarcely touch the seat, being almost suspended then having brought another seat and placed one or more leather pillows under the arm so as to keep it a moderate height while it is bent at a right angle the best plan is to put round the arm a broad and soft skin or broad shawl, and to hang some great weight on it, so as to produce moderate extension or otherwise, while the arm is in the position I have described, a strong man is to take hold of it at the elbow and pull it

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tins to avoid moisture from the atmosphere producing the above crystallisation and so rendering the plaster useless

2 Book muslin 32 threads to the inch This may or

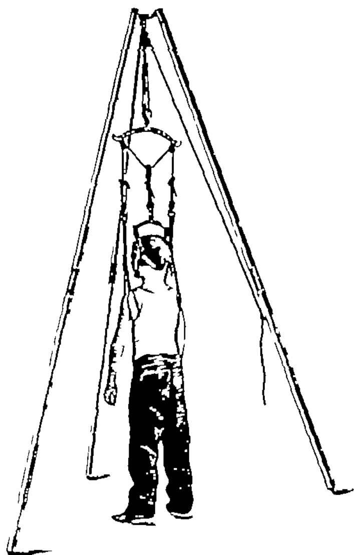


Fig 1 —Sayre suspension apparatus. Used for the application of head suspension plasters in tuberculosis of the spine scoliosis, and backache

may not be impregnated with starch according to the preference of the surgeon This is cut into strips 2 in 4 in and 6 in wide and 4 yds long My own preference is for unsized, non starched muslin as this retains the plaster powder better

downward. But the physician, standing erect must perform the proper manipulation He used fixed traction for leg fractures

Bruynswyke (1525) in a text book on surgery described various forms of extension apparatus, similar to modern screw traction apparatus.

Splints and stiffened bandages have been used for immobilisation for some two thousand years. Bandages soaked in gum were used by the ancient Egyptians for the immobilisation of fractures whilst bandages stiffened with egg white were popular in the Middle Ages

We first hear of plaster of Paris being used as a splinting agent in the writings of Rhazes, an Arabian physician, during the ninth century The advance to the walking plaster came in 1887 when Krause described the results of ninety-eight fractures of the lower limb treated by this method, but the method was never popular until Böhler in the second and third decades of this century demonstrated the value of functional use of the injured limb by means of walking plasters.

To-day one finds plaster of Paris being used to a greater extent than previously replacing various types of splints.

PLASTER OF PARIS TECHNIQUE

To make Plaster Bandages.—Materials required are

1 Fine dental plaster Plaster of Paris is made by heating and crushing calcium sulphate. Heating causes the calcium sulphate to lose its water of crystallisation, resulting in an amorphous anhydrous form of the salt When plaster of Paris is soaked in water chemical union with water and recrystallisation occurs This process is coincident with "setting During this process the plaster expands a little in all directions, and thus a cast encircling a limb will set with its internal diameter slightly reduced

   It is important that the powdered plaster and the finished bandage should be stored in air tight

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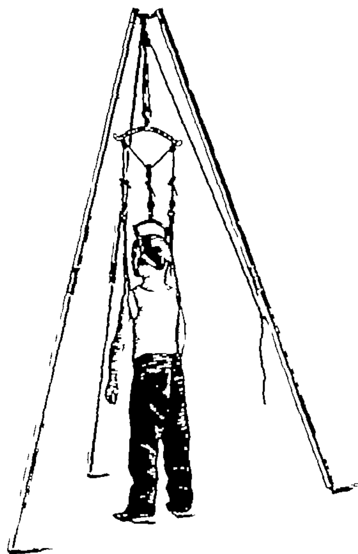


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plaster (Fig 3) A thin even layer of plaster should be left adherent to the bandage which should be re rolled loosely If rolled too loosely the plaster will fall out, but if it is rolled too tightly the water will not soak into the interior of the bandage

The bandage should be wrapped in paper and stored in tin boxes and kept dry

Application of Plaster Bandages—The part is washed with soap and water dried and powdered and then fixed in the desired position and maintained rigid during application and until the cast is set It is important that no movement of the limb should occur during the application otherwise the plaster will crack and disintegrate rapidly If the limb is moved after the cast has been applied creases will form which are very liable to cause pressure sores

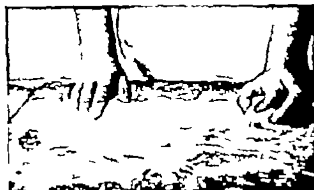


Fig. 3—The plaster powder is rubbed into the muslin and the bandage re rolled.

Bony prominences should be padded with felt, made adherent with mastisol If a padded cast is desired lint bandage or stockinet may be applied to the limb Unpadded skin tight plasters are preferable as a smooth even fit can thereby be obtained which immobilises all the parts of the limb

Padding with lint or stockinet alone for conditions where no swelling is to be feared has no advantage over an unpadded cast It has the disadvantage that folds and uneven application of the padding are potent causes of pressure sores Well padded plasters using wool however are necessary following operative measures such as those required for compound fractures, acute osteomyelitis and sequestrectomy which result in considerable reactionary swelling

The surgeon and his assistants may apply vaseline to their hands to facilitate removal of any plaster which may still adhere after completion of the plaster

3 Plain lint cut into bandages of various widths or stockinet for use in padding plaster-casts
4 White felt. Felt is liable to be contaminated with tetanus spores and should be autoclaved before use to avoid any possibility of tetanus from infection of a plaster sore
5 Aluminium or malleable iron strips 2 ft. long, $1\frac{3}{4}$–$\frac{1}{2}$ in wide, and $\frac{1}{8}$ in thick
6 A large bucket. Lining the bucket with grease-proof paper before filling with water will allow easier cleansing
7 Fracture or orthopaedic table
8 Suspension frame (Fig 1)

Making the Plaster Bandage.—The strips of muslin have three threads drawn from each side otherwise the threads



Fig 2.—Three threads are drawn off each edge of the muslin strip.

fray and separate, thus preventing uniform unrolling of the bandage when the plaster is being applied (Fig 2) These strips are then loosely rolled The plaster powder should be placed on a smooth surface in a heap and the bandage unrolled gradually and passed through the plaster rubbing the latter into the muslin which is gradually re rolled so as to allow 12–16 in. of the strip to be exposed to the powdered

out on a table to exclude air bubbles, and then applied to the limb The edges should be turned back so as to allow a gutter of ½ in between them thus facilitating later removal

Commercial plaster impregnated fabric may now be obtained in 24 in and 36 in widths (e g Cellona) and is useful in the absence of a trained plaster team

Removal of a Plaster-Cast —Requirements

1 Plaster shears The shears should have the lower blade ¼ in longer than the upper to facilitate removal of the cast

2 Saws

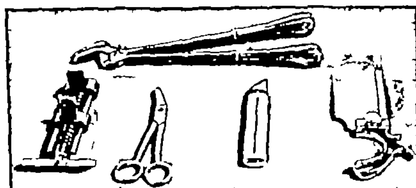


Fig 5 —Instruments for removal of plaster casts.
Plaster Shears.
Plaster-spreader Small Plaster Shears. Plaster Knife. Plaster Saw

3 Plaster knives

4 Plaster spreader—to open the cast when cut by shears. (Fig 5)

When removing a plaster-cast, the shears should cut the plaster over soft tissues and not where there are bony prominences The shears should be advanced slowly taking small bites with each cut. Care should be taken not to depress the lower blade so as to avoid cutting the skin and to prevent painful pressure on the limb After removal of the cast the skin should be washed and dried Desquamation should be treated by the application of vaseline

Nursing of Patients with Plaster-Casts —Although plaster sets within a few minutes it takes twenty four hours for it to dry The plaster should be protected from abnormal

The plaster bandage should then be soaked by placing in a bucket of *tepid* water until all bubbles have ceased to appear It is then taken at the edges in both hands and gently twisted to express surplus water (Fig 4) The bandages should be quite wet throughout to allow easy working and they should be applied smoothly and evenly and without tension the cast being rubbed constantly so as to make it one homogeneous mass and not a series of layers of bandages Air bubbles must be expelled as they are liable to cause cracking of the cast when drying Additional strength can be obtained (1) by using plaster slabs made from unrolling the wet bandages to and fro on a table, or (2) by incorporating metal strips



FIG. 4—Water is expressed by gently twisting the edges of the bandage

Finally the cast should be given a smooth surface by rubbing in plaster cream and the edges trimmed to avoid chafing of the skin In children the life of the cast will be prolonged if the dry cast is made waterproof by covering with a layer of shellac varnish.

The normal time of setting of the cast is 8–10 minutes when tepid water is used This time can be reduced if salt is added to the water in the proportion of one handful to two gallons of water and increased by addition of glue, gelatine or borax (one tablespoonful to two gallons)

When large numbers of plaster casts have to be applied particularly hip and shoulder spica casts, the creamed fabric method of application is an advantage By this method sheets of book muslin are cut to special shapes so as to clothe large areas of the limb These shapes can be cut by an assistant whilst the operation is in progress thus saving time

First a plaster cream is made by adding plaster powder to water until the powder ceases to be absorbed and floats on top and then mixing The cut fabric is then drawn slowly through the cream and the creamed fabric smoothed

Nerve Lesions due to Plasters —These may follow pressure from incorrectly fitting plasters and are most likely to occur in the lower limb if no padding is placed near the head of the fibula Pressure is then exerted on the external popliteal nerve as it winds round the lateral aspect of the neck of the fibula and paralysis results

SPECIAL PLASTER CASTS

Shoulder Spica.—The shoulder spica plaster is used to immobilise the shoulder joint and the humerus in the treatment of osteomyelitis and wounds of the humerus and shoulder joint, and for tuberculosis of the shoulder joint.

To apply the shoulder spica two patterns of fabric or ready prepared plaster fabric *e g* Cellona 24 in wide, are cut as in the diagram (Fig 6) These are applied to the anterior and posterior aspects of the thorax and placed over the affected shoulder and are then strengthened by encircling plaster bandages The arm is enclosed in a plaster-cast made by using strips and encircling bandages, and the two parts of plaster are then joined together by bandaging in a figure-of eight manner so as to enclose the shoulder completely The junction is strengthened by inserting strips of plaster on the under surface of the axilla The completed cast should extend to the iliac crests in order to immobilise the shoulder joint completely (Fig 7)

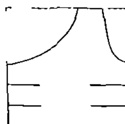


FIG 6 —Pattern for shoulder spica



FIG 7 —Shoulder-spica plaster applied

movement or pressure to avoid cracking and should be left exposed to the air and not covered with blankets to prevent softening during this period of sweating"

With plasters of the lower limbs the limb should be supported on a pillow to avoid pressure on the heel In the case of hip spica plasters, care should be taken to avoid turning or lifting the patient by means of the enclosed limb as this will cause the cast to break. The colour and the presence or absence of swelling of the exposed parts of the limb should constantly be watched Oedema and blueness or pallor of the exposed distal parts indicates interference with the circulation and must be relieved by splitting the plaster open

Plaster Sores.—Plaster sores are localised areas of gangrene, due to localised pressure producing ischaemia and subsequent death of the tissues

Correct, even application of the plaster followed by careful nursing will avoid plaster sores. Irregular padding or application of the plaster or cracking or ridging of the cast due to premature movement, are frequent causes of areas of pressure and necrosis, and careful attention to the technique of application and drying of the plaster will prevent such complications Patients in large casts should be regularly turned in bed to prevent pressure sores developing in any one area. A nurse should report any complaint of pain in the enclosed part by a patient with a plaster cast, as this is the first warning symptom of an impending plaster sore The surgeon may then change the whole plaster or remove a window over the painful area to relieve the pressure and so prevent the development of a sore. If a window is cut, a pad of wool is placed on the skin and the window closed If a sore has already developed, acriflavine or eusol dressings are applied until the wound is clean

If there is pressure at any particular point on the edge of a plaster examination will often reveal that the plaster is loose and fits badly elsewhere, allowing mobility in the plaster Wool should not be packed under the plaster at these points as the pressure is thereby increased and the possibility of the development of a plaster sore increased Correct re-application of the plaster of Paris is the only satisfactory remedy

plaster bandages and the cast is reinforced by strips applied as per diagram (Fig 12) and finally trimmed at the axillae to allow free use of the arms

The cast should extend from the clavicles anteriorly



Fig. 10 —Single hip spica—anterior view



Fig 10a.—Posterior view Note plaster cut away for nursing purposes.

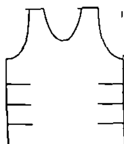


Fig 11 —Pattern for plaster jacket cut from plaster fabric.

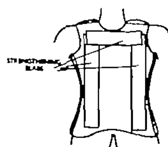


Fig 12 —Plaster jacket showing position of strengthening slabs.

down to the symphysis pubis and to the greater trochanter

Plaster Bed —The plaster table is covered with mackintoshes and the patient placed face downwards upon this The head and thorax may be blocked up with pillows to produce hyper-extension of the spine if the surgeon desires

Single Hip Spica.—The single hip spica is used for immobilising the hip joint and the femur and should extend from the nipple line to the toes. To apply: A leg cast is applied in the usual manner and the trunk enclosed in a plaster-cast made by encircling bandages or from pre-cut plaster fabric, strengthened with strips applied in a transverse manner (Fig. 8.) The two parts of the cast are then fixed together by plaster bandages applied in a figure of eight manner round the hip enclosing plaster strips in these, in the manner shown in the diagram (Fig. 9.) When dry the plaster is trimmed for nursing purposes at the back and also over the epigastrium to facilitate respiration (Fig. 10.)



FIG. 8.—Hip spica applied on orthopaedic table for delayed union of femur. Note webbing support to prevent backward angulation.

Plaster Jacket.—Before applying the plaster the bony points, *i.e.* the spinous processes and the iliac crests are

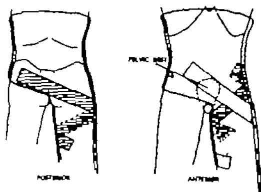


FIG. 9.—Application of strengthening strips: two anterior and one posterior.

padded with felt and a stockinet vest applied. Five thicknesses of pre-cut plaster fabric, cut according to diagram (Fig. 11) are then applied to the anterior and posterior aspects of the trunk. These are bound together with encircling

plaster bandages and the cast is reinforced by strips applied as per diagram (Fig 12) and finally trimmed at the axillae to allow free use of the arms

The cast should extend from the clavicles anteriorly



Fig 10 —Single hip spica—anterior view



Fig 10A.—Posterior view Note plaster cut away for nursing purposes.

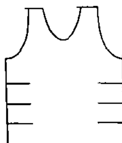


Fig 11 —Pattern for plaster jacket, cut from plaster fabric.

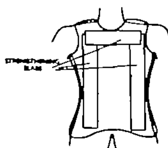


Fig 12.—Plaster jacket showing position of strengthening slabs.

down to the symphysis pubis and to the greater trochanter

Plaster Bed —The plaster table is covered with mackintoshes and the patient placed face downwards upon this The head and thorax may be blocked up with pillows to produce hyper-extension of the spine if the surgeon desires

this (Fig 18) Plaster fabric or prepared plaster fabric, *e g* Cellona 24 in wide is cut so as to cover the entire trunk and legs and occiput. The back of the patient is first covered with a layer of gamgee and the creamed fabric or prepared fabric is then applied in single layers over the patient, each layer being well moulded to the body contour Between each layer longitudinal strips are applied in numerous directions to reinforce the plaster

The bed is completed by smoothing the plaster with plaster cream and then lifted off the patient and set aside to dry steadily This takes approximately three days, after



FIG 18.—Preparation of a plaster bed. Note the slight extension of the spine.

which it is then trimmed at the edges and bound with adhesive plaster and a circular hole cut posteriorly for nursing purposes The bed is then mounted in a wooden frame in order that the patient can be easily carried out of doors for heliotherapy (See Fig 152) An anterior shell is then made for the patient in a similar manner but this time the patient rests in the previously prepared bed

Removable, Convalescent Plaster Splints.—These are used for nerve lesions and arthritis, where the splints are removed daily for physiotherapy and then replaced They are made by making a full limb cast, bivalving this and using one or both halves

Walking Plasters—The present-day practice of insisting upon full functional activity of the injured limb involves the

use of some means of allowing the patient to walk in his plaster-cast Application of a walking iron to the plaster is the commonest method used to obtain this (Fig 14) The iron is a U shaped stirrup made of metal which may or may not have a piece of rubber attached to its base to prevent the patient slipping in wet weather It is applied to the leg plaster cast so that the side irons coincide with the axis of the tibia and should extend 2-2½ in i e three fingers breadth below the foot.

Alternative methods consist of the application of sorbo rubber heels to the cast or a wooden or plaster foot piece consisting of a heel and metatarsal bar The latter is preferable to the walking iron as natural walking is possible with it, whereas with a walking iron there is a tendency to walk with an extended knee and everted foot, a habit which is often difficult to eradicate when the plaster is removed

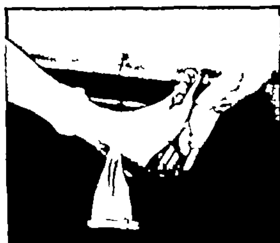


Fig 14—Application of a walking iron Note the distance below the original plaster

If a patient who has had a plaster applied is being treated as an out patient, he must be fully instructed that he is to keep the part elevated for twenty four hours in order to minimise any swelling which may follow manipulation of the fracture He should be told to report back to hospital immediately if any signs of circulatory obstruction such as coldness blueness, or tingling of the fingers or toes, appear If fingers are swollen, it is wise to remove any rings if necessary by cutting them with a ring cutter as their presence will facilitate circulatory embarrassment in the swollen digit Gangrene of the finger may result from neglect of this precaution

In most clinics printed instructions are given to the patient to prevent any misunderstanding of verbal instructions

SPLINTS, CASTS, AND BRACES AS APPLIED IN DIFFERENT REGIONS OF THE BODY

THE FOOT

Arch Supports —Arch supports are used in the treatment of pes planus and pes valgus and may be made of felt, sponge rubber or metal They should extend from the heel to the heads of the metatarsal, being wider at the anterior edge than posteriorly Felt supports have the advantage of cheapness and can be fixed into the shoes Metal supports are usually advised only for severe cases of flat foot which do not respond to conservative treatment, and where operation is declined or contra indicated They should be made to fit each individual foot, and to do this one must make a plaster model of the foot from a mould Plaster moulds are made by immersing the foot in a shallow bowl of plaster cream and the cream then allowed to set around the foot The mould is removed and the inside greased with vaseline and filled with plaster of Paris When set, the mould and model separate, and the arch support can be made to fit the model exactly An alternative method of producing the model is to make a plaster-cast of the foot and ankle, bivalve the cast and grease the inner surface The two pieces of the cast are then fitted together and held in position by a bandage, after which the reconstituted cast is filled with plaster cream When set, this produces a model of the foot

Metal side supports may be added to the arch supports so as to grip the os-calcis and prevent external rotation of this bone

THE ANKLE

Ankle braces are designed to bear weight and to correct or prevent deformity when some weakness of the muscles of the calf is present

1 **Drop-Foot Splints** —Drop-foot splints are designed for paralytic drop foot and consist of two lateral steel bars

connected just below the knee by a leather band The tendency to drop foot may be counteracted by a spring extending from the calf band to the toe, or by a stop fitted to the side irons at their insertion into the shoe The stop allows dorsi flexion but prevents any plantar flexion beyond 90 (Fig 15)

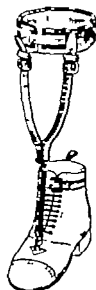


FIG. 15 —Toe-raising for drop foot A single side iron is usually worn in conjunction with the spring

2 **T-Straps** —T straps are designed to prevent any deviation of the foot into a varus or valgus position (varus = deviation towards the middle line valgus = away from the middle line) The principle is to have a vertical steel bar extending from the shoe heel to a calf band just below the knee, as a fixed point, the foot being pulled towards this and so into a corrected position by a strap attached to the bar and the opposite side of the shoe Thus a varus T-strap is attached to an inside iron and corrects a varus deformity A valgus T strap is attached to an outside iron and corrects valgus deformity (Fig 16)



FIG 16 —Shoe with outside iron and inside T-strap

3 **Plaster-Casts.**—A plaster-cast applied to immobilise the ankle should extend from the knee joint to the toes with the foot fixed at 90 to the tibia

THE KNEE LEG AND HIP

(1) **Knee Cage** —A knee cage consists of steel bars which extend from the mid thigh to the upper one third of the calf and which have a joint opposite the knee This joint has stops arranged to restrict flexion and extension to a

prescribed degree (Fig 17) The splint is used for certain cases of torn semilunar cartilage and torn cruciate ligaments.

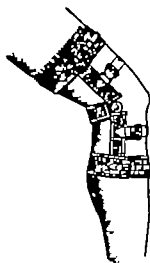


Fig 17 —Marsh knee cage. Used for certain types of instability of the knee joint.

(2) **The Thomas Splint** —The splint known as the Thomas splint was originally devised by Hugh Owen Thomas as a bed knee splint. It consists of an oval iron ring narrower on the medial aspect, which is fused on to inner and outer iron bars The inner bar is set at an angle of 120 with the oval ring and is joined to the other bar at the opposite end by a W shaped iron bar The latter allows traction tapes to be tied to the end of the splint The oval ring is padded and covered with leather and is made in various sizes

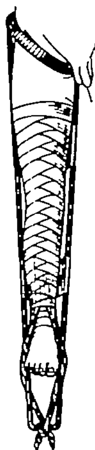


Fig. 18 —Thomas splint in position with traction applied.

The splint may be used in two ways

(*a*) By using the splint as a sling for the leg with weight and pulley extension applied on a Balkan beam

(*b*) By fixed traction on the splint

The oval ring of the splint should fit the upper part of the thigh firmly and should abut on the ischial tuberosity the latter forming a counter pressure point Fixation of the limb on the splint is obtained by traction tapes tied on the W shaped end after passing round the splint as in diagram (Fig 18)

In the case of fractures of the femur the size of the splint should be estimated by testing the fit of the ring on the good limb A badly fitting ring will sag below the ischial tuber-

osity and pressure sores will occur in the groin Again too large a ring presses in the perineum and interferes with micturition and defaecation

Having selected the correct splint, supports for the limbs are made from domette bandage by attaching slings to the longitudinal bars of the splint with clips or safety pins These slings should be sufficiently tight to ensure that three quarters of the limb is lying above the longitudinal bars of the splint. The splint may be suspended from a Balkan beam to allow easy attention to the back and pressure points, or it may be elevated from the bed by means of a foot clip applied to the distal end of the splint

Nursing attention to the skin of the groin and the ischial tuberosity is required three hourly for the first two days and afterwards twice a day The skin under the ring should be moved to change the site of pressure and the skin thoroughly massaged with a small amount of spirit. The toilet should be completed by dusting with powder Each time the nurse should note if the ring of the splint is firmly pressing upon the ischial tuberosity

The Thomas splint is used in the treatment of fractures of the shaft of the femur and for immobilisation of the knee joint in acute arthritis and tuberculosis of the knee It is ideal for the transport of patients suffering from injuries to the lower limb



FIG 19 —Thomas walking caliper

(3) **The Thomas Walking Caliper** —The Thomas walking caliper is similar to the Thomas splint, but the W shaped junction at the lower end is replaced by two small iron rods which slot into holes made in the boot heel

The ring should fit the groin perfectly and all weight should be borne by the ischial tuberosity The length of the splint is so adjusted that the patient cannot feel his heel in his shoe thus avoiding weight being borne directly by the lower limb A knee strap is fitted to ensure a firm fit

The caliper is used following fractures of the shaft of the femur and operations and diseases of the knee and hip joints when non weight bearing movements are allowed (Fig 19)

(4) **Braun Frame or Splint.**—The Braun frame or splint is used for fractures of the lower extremity below the knee when continuous traction is being used and when marked swelling is present, occasionally for fractures of the femur and for infective and traumatic conditions of the soft parts of the leg The splint should be fitted with strips of domette bandage or lint secured laterally by clips or safety pins or preferably bandaged with a continuous flannel bandage (Fig 20) This should be taut except where it supports the calf and should pass on to the under surface of the splint A bed supporting the splint should have fracture boards beneath the mattress and the provision of a box, on which the patient can exert pressure with his good leg aids movement in bed

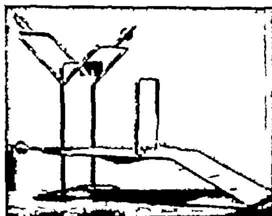


FIG 20 —Braun frame, bandaged ready for application. Note that the bandage is tight above the angle for the knee and that it is carried on to the under surface of the splint. The bandage is loose where the calf of the leg should rest.

(5) **Böhler Screw-Traction Leg Frame** —*This is used for* reduction of fractures of the tibia and for certain fractures in the region of the ankle joint. (Fig 21) The cross bar for the knee is angled in a Z manner to make provision for the greater bulk of the tendons on the medial aspect of the knee.

(6) **Thomas Double Hip Frame** —This is used for the treatment of tuberculosis of the spine (Fig 22)

(7) **Jones Abduction Frame** —The Jones abduction frame is a modification of the above, and is used for acute arthritis and tuberculosis of the hip-joint (Fig 23) To apply the

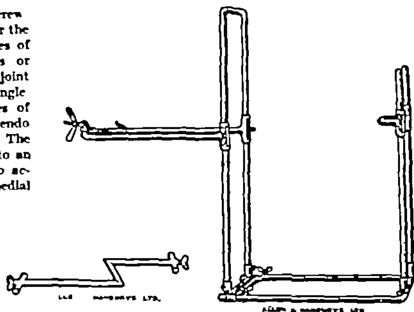


FIG. 21.—Böhler screw traction apparatus for the reduction of fractures of the lower leg, talus or os calcis. The knee joint is flexed to a right angle whereby the muscles of the calf and the tendo achilles are relaxed. The cross-bar is shaped to an angle on one side to accommodate the medial flexor tendons.

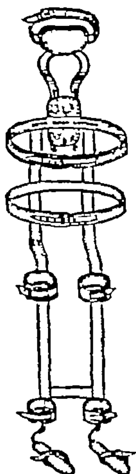


FIG. 22.—Double Thomas hip frame with head-piece used for the treatment of spinal caries in children.

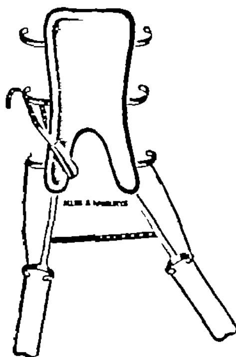


FIG. 23.—Sir Robert Jones abduction frame.

patient is lowered into the frame with the buttocks on either side of the gap used for nursing purposes Both limbs are fixed to the leg frames by skin traction tapes, just as one fastens a leg to the Thomas splint A perineal band is applied to the unaffected side to provide a point of counter-extension, and pads of wool are placed behind the knees to prevent hyper extension of these joints The wings of the splint are then moulded to the body and fixed together The perineal strap should be loosened four hourly during the first two days and then twice a day for attention to the skin Each time the skin should be rubbed with spirit until dry then dusted, and the strap re fixed if possible, over a new area of skin and with the same degree of tension



Fig 24 —Thomas hip splint

For toilet, the frame should be raised by placing a box or wooden block under the trans verse bar at the foot end of the frame To make the bed, remove the bed clothes, leaving a blanket covering the patient. The patient and frame are lifted by four attendants on to a trolley and the mattress is then turned and a clean bottom sheet applied to the bed The draw sheet and draw mackintosh are folded to about 14 in. wide and the patient and frame then lifted back on to the bed

(8) **Thomas Hip Splint** —The Thomas hip splint is used in the convalescent stages of tuberculosis of the hip (Fig 24) It consists of a padded metal bar 2 in wide, moulded to the body and extending from the level of the lower border of the scapula to about 8 in above the ankle. It is attached to the body by two circular bands and a shoulder band, and is fixed to the leg by leather cuffs above and below the knee

and at the lower end of the splint The knee cuffs prevent abduction strain on the knee joint The iron bar is curved below to end on the medial aspect of the leg thus preventing adduction and internal rotation

(9) **Hodgen Splint.**—The Hodgen splint was designed originally for the treatment of fractures of the femur It resembles a Thomas splint but the upper ring is replaced by a half ring which does not serve as a fixed point for extension The side-bars are angled at the knee to allow 20°–30° flexion

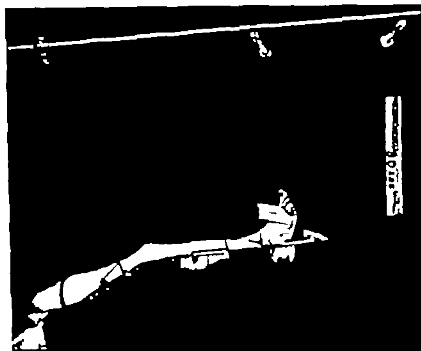


Fig 25 —Hodgen splint applied in the treatment of fractured femur

of the knee-joint. Two hooks are fixed on each side of the bar to allow suspension of the splint from a Balkan beam In use the limb with the knee flexed is laid on cross pieces of domette attached to the splint with clips and is attached to the lower end of the splint by skin traction tapes The splint is suspended with cords attached from the hooks on the side-bars to a single cord which is led over pulleys on the Balkan beam to a weight (Fig 25) It is essentially a splint for applying balanced traction, and cannot be used to apply fixed traction It is conveniently used in the Russell balanced traction method or for treatment of fractures of

the femur and is valuable in the after treatment of arthroplastics of the hip

(10) **Hamilton Russell Balanced Traction**—This is used for the treatment of fractures of the femur and for balanced traction after arthroplastics of the hip (Fig 20) To apply A skin extension is applied to the leg and a sling is used to support the knee. Cord is attached to the sling and passed over a pulley on a Balkan beam directly over the knee, so as to produce a vertical pull The same cord then passes

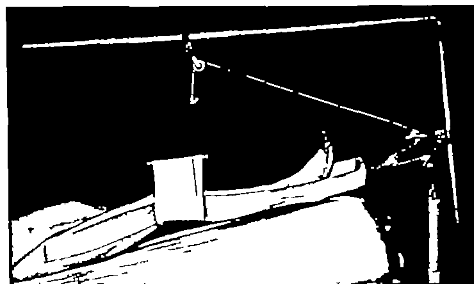


Fig 20.—Hamilton Russell's method of continuous traction.

The sling which supports the knee is attached at each end to a wooden spreader this prevents it from becoming bunched up and causing irritation of the skin. Note the arrangement of the four pulleys required. For the sake of clearness, the pillow which should support the limb has been omitted.

over the pulleys so as to pull on the skin extension in the line of the lower leg The resultant pull of the two forces is along their mathematical resultant, and this produces knee-flexion of about 20–30 with the pull along the line of the shaft of the femur The limb is supported on pillows and no splint is required

THE SPINE AND PELVIS

Sacro-Iliac Belts—These are used for the treatment of sacro-iliac strain when other methods of treatment are

refused The belt consists of a canvas pad reinforced with metal stays extending from the crest of the ilium to the upper part of the coccyx. This pad is then fixed to the body by circular and perineal leather bands

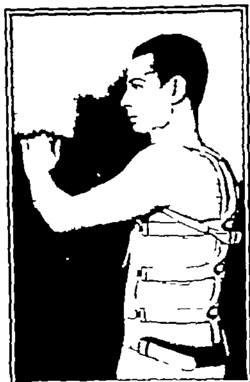


FIG. 27.—Side view of Taylor spinal brace

Spinal Braces —Spinal braces are used in the convalescent stages of tuberculosis of the spine and infantile paralysis affecting the spinal muscles, and in certain affections of the spine where movement causes pain. In principle they consist essentially of two parallel steel bars placed on each side of the vertebral column They are moulded to the back and fixed below by a pelvic band and above by a leather band at the level of the scapula. Leather straps encircling the shoulders are then fixed anteriorly to the pelvic band by additional leather straps (Fig 27)

Bradford Frame —The Bradford frame is used for tuberculosis of the spine and for infantile paralysis of the trunk

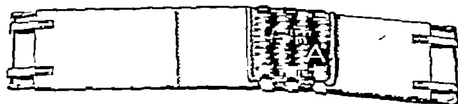


FIG 28 —Bradford spinal frame Note the detachable part A, which can be removed for nursing purposes.

and back muscles It consists of a rectangular gas pipe frame ½ in. 1 in in diameter slightly wider than the patient s

shoulders and 12 in longer than the patient, on which is placed a canvas cover ¾ in less than the width of the frame and 2 in less than the length. A blanket, a sheet a draw mackintosh and a draw sheet are then placed over the frame These, and the cover are in three segments, the centre segment being removable and placed in a convenient position for nursing purposes. (Fig 28) Restraining bands for body, arms and legs are added

Whitman Frame.—The Whitman frame is a modification of the Bradford frame being three-quarters of the width



Fig 29.—Whitman frame. Used with head and leg traction for spinal caries.

of the patient and angled to produce extension of the spine (Fig 29)

THE SHOULDER

(1) **Thomas Arm Splint.**—This resembles a Thomas knee splint but the ring is round and swivels on the side-irons It is used as a temporary splint for the transport of injuries of the upper extremity When used alone it is unsatisfactory for prolonged treatment as traction is applied with the elbow extended This is an unphysiological position for traction and if this is prolonged, stiffness of the joint results It is excellent if modified by adding a flexion bar and applying traction with the elbow flexed at 90

(2) **Simple Abduction Splint.**—This consists of metal troughs for the arm and forearm attached to a metal side-

piece, so as to hold the arm in 60°–90 abduction, external rotation and 20 flexion the elbow flexed 90° The splint is



Fig 30 —Simple abduction frame The padding has been removed for clearness. The splint should fit higher in the axilla.

attached to the body by round canvas belts fastened round the trunk and over the opposite shoulder (Fig 30) The

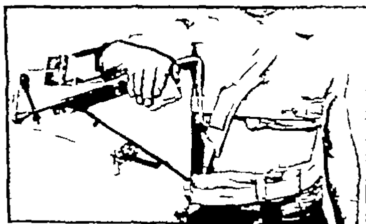


Fig 31 —Abduction frame with continuous traction applied It is used for certain fractures of the humerus. Note that these splints are made to fit either a right or left arm and cannot be interchanged

abduction splint with traction attachment is similar to the above and is designed to exert traction on the humerus in the abducted and externally rotated position (Fig 31)

(8) **Böhler Arm Screw-Traction Frame**—This is used for the reduction of fractures of the humerus (Fig 32) including

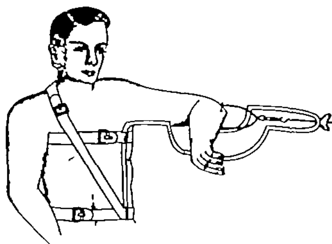


FIG. 32.—The Böhler arm frame is applied with suitable padding beneath the straps. A Kirschner wire is inserted through the olecranon process and a stirrup fixed. Screw traction is applied with the forearm flexed at right angles and pronated.

those of the lower third and the neck of the scapula Traction is applied through a Kirschner wire inserted through the olecranon process

THE FOREARM

(*a*) **Carr Splint.**—The Carr splint consists of a straight dorsal splint, and a palmar splint hollowed out for the thenar eminence An oblique rounded bar is fixed to the lower end of the palmar splint to allow the fingers to grip the bar The splints are bandaged to the hand and forearm (Fig 33) The splint is useful for

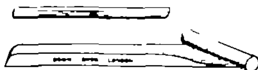


FIG. 33 —Carr splints.

first aid treatment of a Colles fracture but it should never be used for the complete treatment, as full finger movements cannot be practised and radial or ulnar deviation cannot be prevented

(*b*) **Cock-up Wrist Splint**—This is used to support the wrist in dorsi flexion and is useful for musculo spiral nerve lesions It consists of a straight metal gutter, the concave side of which fits the flexor aspect of the fore-arm (Fig 34) This is continued downwards into a dorsi flexed palmar piece which should not extend beyond the distal skin crease of the palm in order to allow full movement of the metacarpo-phalangeal and inter phalangeal joints The thumb should be free of the splint to allow unhindered action of the opponens pollicis muscle



Fig 34—Sir Robert Jones pattern "cock up" splint.

METHODS OF APPLYING TRACTION TO LIMBS

The Balkan-Beam—This is used as a means of attachment for splints and pulley in the treatment of fractures of the limbs Single and double types are available (Fig 35) The single type consists of two upright wooden or metal

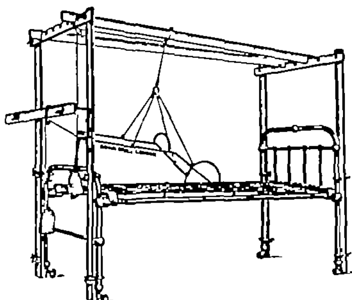


Fig 35—Double Balkan beam.

posts connected over and under the bed with cross bars A beam which can be moved independent of the bed is an advantage, as one fixed to the bed allows only a limited degree of hip abduction which is unsatisfactory in certain fractures of the femur Double beams are usually fixed to the bed



FIG 36.—Cuts are made at the side of the strapping the better to mould it to the contour of the limb.

Skin Extension—Skin extension is a valuable means of applying traction to a limb which is free from certain risks applicable to skeletal traction, *e g* sepsis along the pin track and joint infection when inserted near joints If holland strapping or flexoplast orthopaedic strapping is used it can be safely left on for 8–10 weeks without skin irritation Ordinary zinc oxide strapping should not be used because of the tendency to be followed by this complication To make the strapping extension, two strips of the strapping are taken, 2½ in –3 in. wide at the narrow end and 5 in –6 in wide at the other In the case of fractures they should extend at least 8 in above the site of fracture The strips should extend for 3 in below the malleoli in the case of the lower limb and the epicondyle in the case of the arm and should be cut diagonally on both sides for 1 in to allow a smooth fit to the limb The lower free ends are then folded to make them thick, and covered with a 3-in strip of strapping to make it non adhesive The unfolded pieces are stitched together and a loop of tape is stitched to this thickened strapping (Fig 36) The strapping is applied evenly to the side of the unshaven limb after heating by placing it round a jug of hot water The straps should not overlap They are held in position by a crêpe or flannel bandage extending from the commencement of the straps to 2 in above the malleoli No cross straps of adhesive strapping are used as these are unyielding compress the limb and cut the skin A piece of lint or bandage is placed between the strap and the skin of the malleoli to prevent adhesion

Weight-extension is applied by cord attached to the tapes, or the tapes may be tied to the end of the splint (Fig 37)

Another method is to incorporate a wooden spreader in the centre of a long double strap (Fig 38) Each half of the strap is then applied to the limb and fixed as in the above method A cord is then attached to the spreader and tied to the weight or to the end of the splint

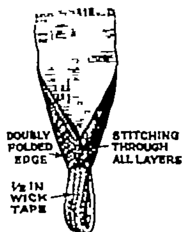


Fig 37 —Method of affixing lamp wick loops to the extremity of a strap

Skeletal Traction —Skeletal traction is a very efficient means of applying traction It may be applied by means of a Kirschner wire or Steinmann pin A Kirschner wire is drilled into the bone by means of a hand or electric drill, a stirrup attached and the wire rendered taut by means of the wire tightener (Fig 39)

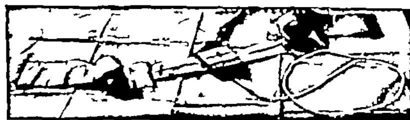


Fig 38 —Skin strapping using a "spreader

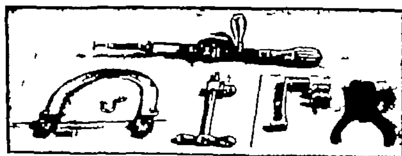


Fig 39 – Instruments for insertion of Kirschner wire

Drill.

Kirschner stirrup with wire -shaped hook is inserted int one of the holes in the stirrup and weight is tied to this. Wire-tightener Stirrup spanner Wire-cutters.

Instruments required are

- One bone drill
- Stainless steel Kirschner wires
- Kirschner stirrup and wire-tightener
- Stirrup spanners
- Wire-cutters
- Tenotomes.
- Gauze
- One pair scissors
- Mastisol

Skeletal traction may be used for traction in the arm by insertion of the wire or pin into the olecranon process, and in the leg by insertion into the os calcis or tibial tubercle. For the leg a Steinmann pin is preferable as there is less likelihood of the nail cutting through the bone. When removing the wire, one end is cut off close to the skin, and the other end and the skin round the wire sterilised with spirit. The projecting end is seized with a pair of artery forceps and the wire withdrawn. The skin punctures are then sealed with gauze soaked in mastisol.

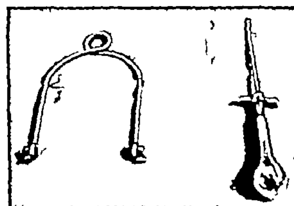


FIG 40.
Böhler swivel stirrup. Steinmann pin with insertion handles.

For the insertion of a Steinmann pin the following instruments (Fig 40) are needed

- Bone mallet
- Steinmann pin and insertor
- Böhler swivel stirrup
- Tenotome
- Bard Parker knife
- Tissue forceps
- Mayo scissors
- Gauze swabs
- Mastisol

The Steinmann pin is hammered into the bone and the skin around the pin then sealed with gauze pads soaked in mastisol (Fig 41) A Böhler swivel stirrup should be used to the exclusion of other types as with this type, the stirrup rotates on the pin and prevents rotation of the pin itself Risks of sepsis are thus reduced as rotation of the pin results in tracking of infection along the pin into the bone When the pin is removed, the entrance and exit wounds, and the whole pin are swabbed with spirit and the nail holder fixed to the pin which is then withdrawn Spirit is applied again to the wounds and these sealed with gauze soaked in mastisol The pads stay in position for 2–3 weeks when the pin track will be found to be healed

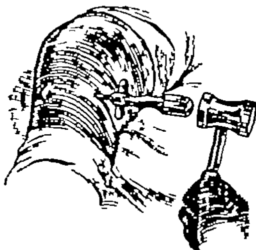


FIG 41 —The nail is driven through the bone until its point appears under the skin, which is nicked with a scalpel.

Pulp Traction —This is used for displaced phalangeal

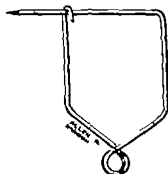


FIG 42.—Pin for pulp traction. They are used for some fractures of the phalanges, metacarpals and metatarsals.

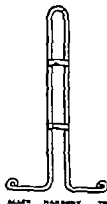


FIG 43.—Böhler finger splint Padding is applied and the splint bent before application The lower part is incorporated in plaster the finger being strapped to the distal part

metacarpal, and metatarsal fractures Stainless steel wire or special pins may be used (Brock pins) (Fig 42) They

are inserted into the pulp of the terminal phalanx the procedure being performed under local anaesthetic if desired



Fig 44 —Cramer wire splinting This splinting can be bent into the desired shape and cut to the requisite length before padding

The pin is then tied under tension to a Böhler finger splint (Fig 43) or a Cramer wire banjo splint. (Fig 44)

Universal gutter splints (Fig 45) may be used as tempor



Fig 45 —Jones universal gutter splints.

ary splints, or as local splints in the treatment of a fractured femur when fixed traction is used They should be padded with wool before being applied

CHAPTER II

ORTHOPAEDIC THEATRE TECHNIQUE

PREPARATION OF THE PATIENT FOR OPERATION

GENERAL pre-operative measures such as pre medication diet aperients, and enemata follow the lines practised in general surgery

Skin Preparation.—For all orthopaedic operations (apart from emergencies) the skin should be prepared for two days The skin should be shaved and washed with ether soap and then cleansed with methylated ether and surgical spirit or 1 per cent mercurochrome applied over the prepared area and the part bandaged in sterile towels Three such preparations are made before operation

If the patient has been wearing a cast or appliance for a long time, the skin is usually dirty and exfoliated necessitating longer skin preparation A soap poultice is applied for 24 hours, after which the skin is washed and white vaseline applied daily until all loose skin is removed The skin is then washed thoroughly eau-de-Cologne applied, and dried well with hot air The usual skin preparation is then commenced An adequate area above and below the operation field should be prepared, as any preparation on the operation table renders the previous care a waste of time When operations are to be performed on the foot or ankle the whole limb from the knee downwards is prepared For operations above the ankle the whole extremity from the groin to the toes, is prepared For hip operations the whole leg and the abdomen and back to the level of the umbilicus are prepared for the shoulder the base of the neck and upper one-third of the sternum and the whole arm The whole arm should be prepared for operations below the shoulder

Tourniquets.—Many orthopaedic operations especially those on joints need the preliminary application of a tourniquet to render the operation field bloodless The limb should be elevated for three minutes before application

of the tourniquet, which must be applied tight enough to occlude the arterial circulation. An Esmarch bandage is very satisfactory for the lower limb For the upper limb, a sphygmomanometer cuff inflated to 180–200 mm mercury depending on the patient s blood pressure, is preferable. An unyielding rubber tourniquet for the arm is to be strongly condemned because of the ease with which a musculo-spiral nerve paralysis may be induced by such compression The tourniquet is not removed until the post operative dressings or plaster-cast are applied, but the nurse should be certain that the tourniquet has been removed before the patient leaves the theatre Neglect of this precaution will culminate in a gangrenous limb and amputation, and possibly legal proceedings

Whilst discussing the use of the tourniquet in the operation theatre one would like to add a timely warning concerning the use of tourniquets for controlling haemorrhage. Apart from the operative indications already mentioned, a tourniquet is seldom required As a rule haemorrhage can be controlled by a firm bandage and elevation of the limb If a tourniquet is applied too tightly there is considerable danger of producing traumatic arterial spasm and nerve paralysis A tourniquet which is not applied tightly enough aggravates the bleeding because the arteries are not occluded, whilst the venous circulation is obstructed

Draping —If the wound is to be kept clean it is essential to cover the whole of the patient, except the area of the operation by the correct application of sterile towels In correct application may lead to slipping of the towels and exposure of unprepared skin during operation A nurse should grasp the covered toes or fingers and raise the limb The skin preparation towels are then removed by peeling from above downwards until only the toes or fingers are covered (Fig 46)

For the foot and ankle two sterile mackintoshes and towels are placed over the lower half of the table and the other leg A further sterile towel is laid over these, approximately at the level of the lower one-third of the leg Another is taken by the assistant, and the nurse then allows the leg to fall into this towel This, and the previous towel are then

wrapped over the limb and toes so as to leave only the site of the operation exposed The towels are clipped to skin to prevent movement. A large operation sheet, which covers the whole of the patient, is laid on with the limb to be operated upon protruding through the centre hole (Fig 47) A sterile stockinet sleeve is then placed over the leg and foot. (Fig 48) At operation, the stockinet is incised the skin incised and the stockinet fixed to the edges of the wound with Michel clips

For the knee a similar preparation as for the ankle is given. The towel into which the limb is lowered should cover the whole of the leg below the knee, and a stockinet sleeve applied as before

When the hip is being exposed the draping is com



Fig 46.—After "peeling" the preparation *towels off the limb the leg is held by the toes* while the sterile operation towels are laid upon the table under the leg and over the sound leg



Fig 47 —Sterile towels are wrapped round the lower part of the leg and foot and also above the knee. The large operation sheet, held in the right hand, has just been applied



Fig 48 —Final stage of "towelling up" Stockinette sleeve has been applied over the operation area.

menced as before, but sterile mackintoshes and towels are placed under the buttocks and across the other limb A further towel is laid in the groin and perineum and clipped to the towels covering the table and the limb The large operation sheet is then placed over the whole of the patient with the centre hole over the site of proposed incision

OPERATIVE TECHNIQUE

In all operations involving bone, joint, or tendon except in the presence of sepsis an absolute no touch technique should be employed The instrument table should be set up entirely by sterile instruments, the instruments to be used being laid with their *handles* on one half of the table The other half of the table should never be touched by the hands All sutures and ligatures should be handled by forceps, and needles threaded by instrumental means Swabs should not be touched by hand, but should be used clipped in forceps When the skin has been incised the knife used is discarded and a second knife used to perform any further dissections

INSTRUMENTS

General Set (Fig 49)

- 1 pair deep retractors
- 1 pair small retractors
- 2 pairs toothed dissecting forceps
- 2 pairs non toothed dissecting forceps
- 2 pairs Mayo scissors
- 2 B P knives (No 22 blade)
- 1 scalpel
- 2 sharp pointed tenotomes
- 2 blunt-ended tenotomes
- 2 dozen long artery forceps
- 4 Lane long tissue forceps
- 2 Faraboeuf rugines
- 1 long probe



FIG 40 —General bone instruments

Bone-nibbling forceps osteotomes (3) (bevelled both sides); drills (3) cartilage forceps sequestrum forceps; gouges (3) [illegible] (4) Lane bone-bending forceps (note long handles) Ferguson lion toothed forceps bone-cutting forceps key hole osteotomy saw metatarsal saw mallet.

1 MacDonald dissector
4 blunt hooks
1 pair sinus forceps
1 aneurysm needle
1 small Volkmann spoon
1 large Volkmann spoon
1 pair sequestrum forceps
1 pair Ferguson lion toothed forceps
6 towel clips
2 needle holders
1 long handled mallet
2 pairs small non toothed dissecting forceps
1 pair stitch scissors

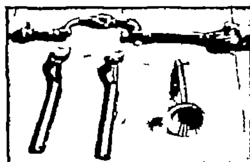


FIG 40A —Acetabuloplasty instruments

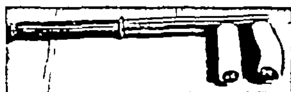


FIG 40B —Thomas wrench. This is used for strong manipulation of the feet and for some deformities of the long bones.

Needles, ligatures, and sutures

Silk or S W G for skin No 2 chromic catgut for aponeurosis and muscles, N 000 for subcutaneous ligatures silk for tendons

Osteotomy

General set and osteotomy saw

menced as before but sterile mackintoshes and towels are placed under the buttocks and across the other limb A further towel is laid in the groin and perineum and clipped to the towels covering the table and the limb The large operation sheet is then placed over the whole of the patient, with the centre hole over the site of proposed incision.

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1 pair small retractors
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2 pairs non toothed dissecting forceps
2 pairs Mayo scissors
2 B P knives (No 22 blade)
1 scalpel
2 sharp-pointed tenotomes
2 blunt-ended tenotomes
2 dozen long artery forceps
4 Lane long tissue forceps
2 Farabœuf rugines
1 long probe

Laminectomy :

General set 2 wide osteotomes
1 medium osteotome
1 pair large, small, and medium bone cutting forceps
2 pairs Horsley or Hudson laminectomy shears (Fig 52)
Horsley wax Suction apparatus

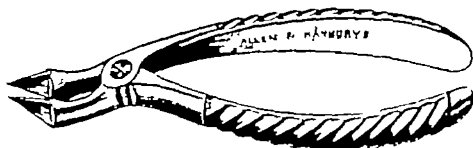


Fig 52.—Horsley laminectomy shears.

Bone Graft

General set Albee saw Hot saline.
Bone drills Vitallium screws
Lowman and Lane bone holding clamps and levers

Sterilisation of Albee Saw —1 The electric cable from the motor to the black rubber union on the connecting cord is

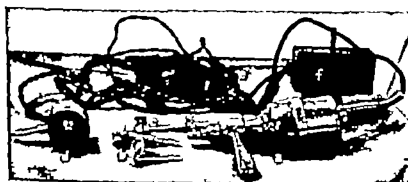


Fig. 53.—Albee motor saw with fittings.
( ) Motor in sterilisable case.
(b) Saws—single and twin.
(c) Saw guard.
(d) Dowel shaper for making bone pegs.
(e) Connecting cables.
(f) Foot switch.

removed from the motor by pulling it out from the plug and boiled (Fig 53 and Fig 54)

Osteomyelitis

General set bone drills, and vaseline gauze.

Plating Fractures

General set.
Vitallium plates and screws set. (Fig 50)

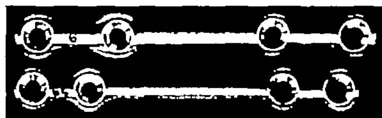




Fig 50 —Vitallium screws and plates.

Drills and Lane bone-holding forceps
Bone levers
2 pairs Lowman clamps. (Fig 51)



Fig 51 —Lowman clamp. Used to hold fractured bones in position during fixation with a screw plate, or graft.

Amputations :

General set.
Amputation retractors and large amputation knife
Corrugated rubber drains.
Large and small amputation saws

For Excision of Semilunar Cartilage :

General set.
2 cartilage knives
1 long narrow retractor
1 Martin bull-dog cartilage forceps

CHAPTER III

GENERAL METHODS OF CORRECTION OF DEFORMITY

DEFORMITIES may result from contractures of the skin fascia muscles, tendons, or joint capsules or ligaments and from intra articular adhesions, causing ankylosis of joints Often many of these structures are contracted together

The axiom "Prevention is better than cure" is especially applicable to the surgery of deformity Prevention is simple but the treatment of the established deformity is usually difficult and prolonged The development of contractures should be prevented by careful splintage of joints in a neutral position and the institution of daily active movements to the unaffected joints For paralysed limbs, the joints should be put through a full range of movements each day

DEFORMITIES DUE TO SKIN AND SCAR CONTRACTURES

Again prevention is to be preferred to treatment of the established deformity and early skin grafting of wounds is undertaken with this object in view

Traumatic loss of skin should be replaced immediately if conditions are suitable using flap- or split thickness grafts A convenient method for injuries of the hand is to place the hand into a pocket of skin raised in the abdominal wall If tendons are exposed due to skin loss and the part cannot be placed in an abdominal pocket, they may be covered with split thickness grafts Often immediate grafting is out of the question and must be deferred until a clean, healthy granulating area is present To prepare such an area for the subsequent grafting eusol dressings, followed by normal saline packs may be applied or preferably the irrigation envelope technique may be employed

2 The handle is removed from the motor shell after releasing the screw which locks the shell and handle to the

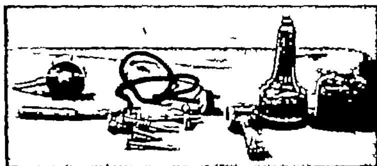


Fig 54 —Parts of the motor saw which must be sterilised Note the part of the cable which must be boiled.

motor The shells handle, and cutting tools are boiled.

3 After sterilisation the long part of the shell is taken in the gloved hand and held with its large, open end up A nurse, holding the large end of the motor in the palm of her hand, inserts the other end into the recipient shell and turns the motor to the right as far as it will go (Fig 55) The other half of the shell is then fitted and locked and the handle screwed on The sterilised cable is plugged into the motor, and its other end plugged into the connection to the foot switch The saw is then ready for use



Fig 55 —The motor held by a "dirty" nurse is inserted into the sterile shell, held by the "clean" operation.

When using the saw a constant stream of sterile saline should be allowed *to flow on to the cutting tool to cool* it To avoid any accident, it is most important that no finger or swab should approach to within 12 in of the saw blades.

is placed over the graft and a firm pressure bandage is then applied The dressings are left *in situ* for ten days when redressing is undertaken

Flap-grafts are usually taken from the abdomen or back for use with a defect of the arm, whilst in the lower limb the opposite leg serves as the donor area A flap of skin is raised on the donor area cut slightly larger than the defect to be closed to allow for shrinkage and hinged at one side The flap is sutured to the edges of the recipient area and the raw area left by raising the flap is covered by *tulle gras* After two weeks, the flap is severed from the donor area and fixation to the defect completed The raw donor area which is now covered by granulations is covered by a Thiersch graft

Split-thickness grafts, consisting of epidermis, dermis and small amounts of corium are cut with a razor or skin grafting knife The thighs and arms are used as the donor area and are prepared by application of spirit and then normal saline.

A selected area of skin is then stretched by means of boards or suction cups and the grafts cut. These are placed on *tulle gras* with the raw surface upwards An excision of the granulations of the recipient area is then performed bleeding being arrested by the application of liquor adrenalin and firm pressure The surface is then lightly dusted with sulphonamide powder to allay infection and the graft placed in position Gauze or sponges soaked in normal saline are laid over the graft and a firm elastoplast bandage applied to maintain firm pressure. Re-dressing is performed on the eighth day

Thiersch grafts are very thin grafts, cut with a razor or skin grafting knife They are used for direct application to granulating surfaces, and their preparation and fixation is similar to the method used for split thickness grafts

DEFORMITIES DUE TO CONTRACTURES OF FASCIA, MUSCLES, AND TENDONS

Deformities due to contractures of fascia, muscles and tendons can usually be manually corrected in the early

Burns and wounds which have healed by granulation tissue are common causes of deformity. The deformity may often be corrected by excising all the scarred tissue and manually correcting the defect. The raw area left after the excision is then covered with a skin graft, using either a free



FIG 56.—Flap-graft to wrist.



FIG. 57.—Flap-graft to leg

whole-thickness graft or a tube pedicle graft, or a flap (Figs 56 and 57.)

Tube-pedicle grafts are usually made by making two parallel skin incisions in the abdominal or thoracic wall and separating a rectangular area of skin. The incision should be as wide as is consistent with closure of the skin wound beneath the raised rectangle or failing this, the wound is covered temporarily with a *Thiersch graft. The rectangle is* then sutured to form a tube using a continuous silk suture for this (Fig 58.) After four weeks, one end of the tube is severed and implanted into the arm and four weeks later the remaining abdominal attachment is cut and the end implanted into the recipient *area The tube is now ready to* replace the excised scar tissue



FIG 58.—Tube-pedicle graft.

A free whole-thickness graft may be cut from any suitable area of skin. It is cut to the shape of the recipient area, but due allowance is made for shrinkage of the graft after it has been cut. The graft is placed *over the raw area and sutured* in position with N 000 000 catgut or ophthalmic silk fixed on atraumatic needles. To aid vascularisation a mould of stent

and the puncture sealed with a collodion dressing The limbs are manipulated into an over corrected position, and maintained in that position for 14–21 days by a cross bar fixed to two plaster boots applied to the feet

Operations to **erase muscle origins** are undertaken to allow the muscle to acquire a new origin nearer its insertion after manipulation of the limb into correct position They are often used for flexion contractures of the hip and elbow, and consist of sub periosteal stripping of the muscle origins by means of rugines After operation the limb is immobilised in a plaster-cast in the over-corrected position

Some deformities are better treated by **osteotomy** of the bone, especially if the adjacent joint is ankylosed or has been infected with tubercle The bone is partially divided by an osteotome or osteotomy saw and the fracture completed manually The limb is then immobilised in plaster with the deformity corrected and the cast is not removed until bony union of the osteotomy is sound (Fig 60)

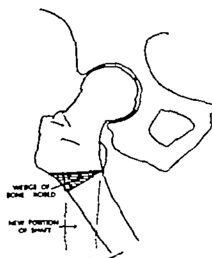


FIG 60 —Osteotomy of femur as for fixed adduction contracture

When a joint is ankylosed in a deformed position or where deformity is associated with painful partial ankylosis an operation may be performed on the joint to correct the deformity and relieve the pain Two types of operation are possible, one producing the opposite result to the other One operation is that of arthrodesis whereby the joint is abolished the other operation is that of arthroplasty where a new joint is fashioned.

Arthrodesis is the excision of the articular surfaces of the joint and apposition of the raw surfaces to allow union to occur The limb is immobilised in a plaster-cast until union across the joint is sound This often takes 3–6 months After removal of the plaster the sutures are removed and a walking caliper is fitted for the arthrodeses of the knee and

stages of their development, because the fibrous tissue is pliable and easily stretched Correction may be possible at this period of development of the deformity by the application of **weight traction**, or by **forcible manipulation** and stretching followed by the application of a plaster-cast to maintain the new position of the part Adequate padding of the cast is necessary to prevent the development of sores The plaster is bivalved after 4–6 weeks, and exercises and massage given, the two halves of the cast being replaced after the periods of physiotherapy until the muscles of the limb are strong enough to prevent recurrence of the deformity

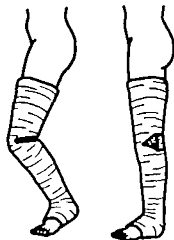


FIG 59 —Wedge plaster for correction of flexion deformity of knee.

A modification of the latter method is the use of **wedge plasters**, this procedure being particularly applicable to deformities of hinge joints such as the knee (Fig 59) The plaster cast applied after manipulation is cut three-quarters of the way across at the apex of the concave side of the deformity A wooden wedge is then knocked into the gap thus enlarging it and so levering the divergent limbs of the cast apart This process is repeated using larger wedges until full correction is obtained

Where the contracture is of long standing strong fibrous tissue is present, and the previous conservative measures are often ineffective Operative measures must then be undertaken These consist of tenotomies tendon lengthening and erasion of the muscle origins

A common example of blind **tenotomy** for such a contracture is the operation of adductor tenotomy The hip is flexed and abducted so as to stretch the contracted tissues A sharp-pointed tenotome is then inserted through the skin just superior and lateral to the taut structures and then laid aside A blunt-ended tenotome is then inserted between the skin and the structures to be divided and the fibrous tissue cut through completely The tenotome is withdrawn

the joint in a deformed position and then secondary shortening of the muscles and soft tissues results

Prolonged immobilisation in plaster of Paris with joints in the optimum position for function does not lead to adhesion formation as is often stated Movement will recover with active exercises

Adhesions tend to limit movement and cause pain when they are stretched *and it is usually found that one particular* movement causes the pain The pain and tenderness is usually localised to the site of the adhesions

Manipulative treatment of adhesions is very successful only when suitable cases are submitted to this form of therapy It is especially contra indicated when any active joint disease is present, *e.g* tuberculosis acute arthritis, and rheumatoid arthritis in the active stages, and in old tuberculosis joints where the disease may recur Manipulation is not a method to be used for stiff joints in old people where rarefaction from senility may result in fracture nor for children because of the risk of epiphyseal damage and because spontaneous recovery is common

Manipulation is particularly useful when locking" of joint surfaces occurs *e g* in torn medial meniscus It may be used in osteo-arthritis, and after rheumatoid arthritis, provided the condition is quiescent.

For successful manipulation good muscular relaxation is essential This is achieved by general anaesthesia, and pentothal sodium is particularly suited for manipulative therapy because of the complete relaxation it gives and because of the shortness of the anaesthesia During manipulation an endeavour is made to increase one movement only and the joint is put through one range of movement only pump handling' of a joint is to be condemned because of the severe reaction likely to follow

After manipulation the joint is rested for 24–30 hours in order to allow the subsequent reaction to subside The joint should be immobilised in the position where the adhesions are lengthened and massage then given, active and assisted movements being commenced on the second or third day dependent on the severity of the reaction

ankle to allow non weight bearing movement of the limb This is worn for six months For arthrodeses in the upper limb no splints are required after removal of the plaster

Arthroplasty is indicated when movements of more than one joint are restricted, and is particularly useful for the elbow and hip joints. The articular surfaces of the joint are reconstructed and remodelled by chisels and rongeurs, and covered by a substance which will allow gliding movement and separate the raw bony surfaces Fascia lata is commonly used but recently vitallium cups have been introduced to replace this The initial results of arthroplasties using this metal are excellent and the new joints are remarkably pain less, but the late results have still to be evaluated. After treatment is very important if success is to be achieved After operation the limb is immobilised by balanced traction to separate the newly formed articular surfaces After three to four days, passive and assisted active movements are allowed the traction being continued after the periods of exercise Traction is discontinued after three weeks, and a full series of active non weight bearing exercises allowed For hip arthroplasties these may be provided by attaching roller skates to the heels and abducting and adducting the limbs on inclined planes With arthroplasties of the lower limb the patient may be allowed up with crutches after the fourth week.

Many deformities need a combination of many of these procedures to correct them One should remember that the operative measures are only an incident in the treatment, and that the after care expended to prevent recurrence is of equal importance

MANIPULATIVE TREATMENT

Manipulation is used as a means of breaking down adhesions in fascial planes and in peri articular tissues which cause pain and restrict movement. An adhesion is a pathological fibrous band which results from the organisation of an exudate due to trauma or inflammation They may be intra articular or extra articular They may develop with

The muscles are cut 1½ in shorter than the skin to avoid their being brought over the bone end and becoming adherent The vessels and nerves are cleanly divided The nerves should not be pulled down before division, and should not be ligated or injected with alcohol or neuroma may result

After ligation of the main vessels, the tourniquet is removed and any further bleeding arrested Only the skin flaps are sutured and a corrugated rubber drain placed in each corner of the wound The latter is gradually shortened following the second day after the operation

A guillotine amputation is an emergency amputation where all tissues are cut through rapidly at the same level and the wound left open to drain It is used chiefly for gas gangrene Particular care should be taken after the operation

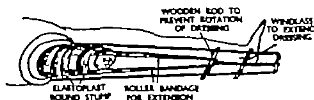


FIG. 62 —Adaption of Thomas splint and ring for skin traction following guillotine amputation.

to prevent retraction of the skin which would leave the bone exposed This is achieved by applying skin traction to the stump (Fig 62)

After-Treatment of Amputations

1 *Above the Knee* —In order to prevent flexion deformity the stump should *not* be placed on a pillow or sandbag but should be allowed to lie flat on the bed A bed-cage should be placed over the limb and the bed clothes turned back in order that the stump is exposed for constant observation Thus the onset of haemorrhage can be quickly noted No massage or passive movements are allowed When the wound is healed crêpe bandaging should be commenced A 6-in crêpe bandage should be firmly applied from below upwards gradually easing the pressure around the stump as the bandage is carried upwards. (Fig 63) This aids the production of a conical stirrup The bandage should be re applied thrice daily Flexion extension, abduction and

CHAPTER IV

AMPUTATIONS

AMPUTATIONS are indicated for irreparable trauma sepsis endangering life, and malignancy

The instruments required are

General bone operation set
Amputation knife
Amputation saws
Amputation tissue guard (Fig 61)

Special Operative Details —For amputations of the lower limbs, the patient should be placed on the operating table

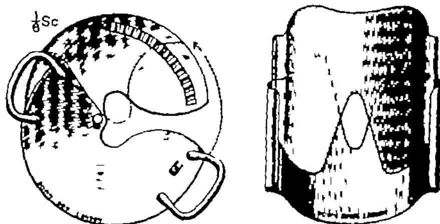


Fig. 61 —Amputation retractors.

so that the limbs are flexed over the end of the table If the amputation is below the knee it is often advantageous to have the patient lying prone

If possible a tourniquet is used to control haemorrhage A large amputation knife is essential for a rapid operation as amputations need to be carried through as quickly as possible In the lower limb flaps are cut to allow the scar to lie just posterior to the coronal plane whilst equal flaps or a circular skin incision can be used in the upper limb

CHAPTER V

FRACTURES AND DISLOCATIONS

BEFORE discussing fractures and dislocations, a few definitions of terms will allow the reader to have a clearer understanding of the various grades of bone and joint defects following the receipt of an injury

A Fracture is the breaking of a bone or of a cartilage

An Epiphyseal Separation is a fracture which passes through or lies within the epiphyseal line

A Dislocation is a complete and persistent displacement of one articular surface of a joint from the others

A Subluxation is a partial or incomplete dislocation which is associated with a laxity of the joint capsule and the ligaments controlling the joint.

A Sprain is a temporary subluxation in which the displaced articular surfaces have returned to their normal positions after causing damage to ligaments, tendons and muscles around the joint Fragments of bone may be avulsed with the ligament.

FRACTURES

THE AETIOLOGY OF FRACTURES

Predisposing Causes —Men are more liable to be sufferers from fractures, largely because of the hazardous nature of certain occupations and also because they take part in athletic activities to a greater extent than women We are all more active between the ages of five and forty and because of this fractures occur most commonly during that period of life Senility however predisposes to the occurrence of a fracture because the bones become rarefied with advancing years

Direct or Exciting Causes —Fractures may be due to external violence or muscular action The violence may be direct or indirect Direct violence causes a fracture beneath the site of impact resulting usually in a transverse fracture

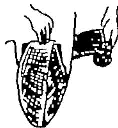
adduction exercises are practised daily and weight and pulley circuits are an advantage in increasing muscle control of the stump Plaster pylons are rarely used as preliminary artificial limbs, crêpe bandaging being persisted with and crutches given until a permanent limb can be fitted. In three months most cases can be fitted with an artificial limb

2 *Below the Knee*—The same treatment as the above

Fig 63.—Bandaging amputation stump



Bandage commenced on front, down front, over end, up back, held there and reverse manner as *shown in second stage.*



Three applications of bandage to support tissue of stump.



Completion of bandaging from lower end *upwards* around abdomen to give support for whole tissue of stump—to perineum also.

(*Patients assist by holding bandage on front—as indicated—similarly at back.*)

must be carried out. In addition, quadriceps drill should be instituted as early as possible after operation

3 *Upper Extremity Stumps*—Active movements of the stump and crêpe bandaging are carried out as for the lower limb An artificial limb can be fitted much earlier than in the lower limb as weight is not borne on the stump

line then spreads longitudinally up the bone, such as occurs when a plant stem is broken Hence the term "greenstick" An infraction fracture resembles a greenstick in type, but differs from it in that the concave border of the bone indents and fractures These fractures are confined almost entirely to children because their bones are more flexible than those of adults and tend to bend rather than break

(*b*) **A longitudinal fracture** is a fracture where the fracture line runs longitudinally along the bone

(*c*) **A transverse fracture** is a fracture where the fracture line runs at right angles to the longitudinal axis of the bone It is always due to direct violence


Transverse.


Oblique.


Spiral.

(*d*) **Oblique and spiral fractures** are due to indirect violence, and in these types the fracture line is oblique or spiral


Comminuted.


Greenstick.


Impacted.

FIG 64 —Types of fracture.

(*e*) **A fracture is said to be comminuted** when there is splintering of the bone fragments into many pieces It is due to direct violence

(*f*) **An impacted fracture** is one in which one fragment is driven into the other and fixed in that position This occurs in situations where the hard cortical bone is being replaced by cancellous tissue, *e g* the upper end of the humerus and the lower end of the radius

Surgeons often describe fractures by the situation of the fracture *e.g* a supracondylar fracture. When a fracture results from trivial violence we describe it as a **pathological**

of the bone and considerable damage to the surrounding soft tissues Indirect violence, i.e violence applied at a distance from the site of fracture and transmitted to that region by bones or ligaments, results in a spiral or oblique fracture due to the torsion strain applied to the bone Any soft tissue damage is due to laceration by the bony fragments themselves A common example of a fracture due to indirect violence is the typical fracture of the clavicle. which results from a fall on the outstretched hand The violence is applied to the hand and transmitted to the clavicle via the bones of the arm and shoulder

Sudden muscular violence may produce a fracture, the common example being the transverse fracture of the patella, which results from a sudden strong contraction of the quadriceps muscle of the leg made to regain the balance when the patient slips from the kerb

CLASSIFICATION OF FRACTURES

There are many methods of classifying fractures Firstly all fractures may be simple or compound. A simple fracture is one in which overlying skin is intact, while a compound fracture is one in which the fracture communicates with the external skin surface by a wound it should be emphasised that a compound fracture does not necessarily mean that the bony fragments are exposed or protruding through the wound Compound fractures are always contaminated and potentially infected by overlying clothing and by dust and soil which may be implanted into the wound at the time of injury

A further subdivision is into the types of fracture depending on the direction and character of the fracture line (Fig 64)

(a) **An incomplete fracture** is one where the whole thickness of the bone is not broken completely across, and these are known as greenstick and infraction fractures. A greenstick fracture is one where the concave side of the bone fractures, and the fracture

and potentially infected The fracture may become compound at the time of injury by the agent causing the injury or it may become compound by the bony fragments lacerating the skin from within It must always be borne in mind that any simple fracture may be converted into a compound fracture by careless handling after the accident, and the fractured limb must always be supported manually or be splinted to prevent this

2 A varying degree of **surgical shock** accompanies any fracture but it is usually severe in compound and multiple fractures.

3 The bone injury cannot be divorced from soft tissue injury but in some fractures the soft tissue injury may be very severe Large blood vessels are very prone to be damaged by the sharp ends of the fractured bones An **artery or vein may be severed,** or a **vein may become thrombosed** as a result of the swelling and stagnation of the blood in the injured limb Thrombosis of the veins is often seen when the pelvis and femur are fractured The bony fragments may injure the arteries without opening the lumen by damaging the sympathetic nerve plexus, which lies on the outer walls of the arteries This causes **arterial spasm,** and so reduces the blood supply to the limb beyond and may result in the development of a Volkmann s ischaemic contracture or gangrene A **traumatic aneurysm** may follow laceration of the artery wall, the aneurysm usually being saccular in type

4 **Nerve Injuries** —A nerve injury may follow the receipt of a fracture because of the proximity of the nerve to the bone or the nerve may be damaged at the same time as the bone by the same violence The nerve may be contused, when the paralysis is partial and recovers spontaneously or severed partially or completely The musculo-spiral nerve is more commonly injured in association with fractures than any other nerve because of its close proximity to the shaft of the humerus Other nerves often damaged are the ulnar nerve in association with dislocations and fractures around the elbow joint and the posterior interosseous nerve in association with dislocations of the head of the radius Nerve lesions may result from ischaemia and pressure of

or spontaneous fracture This is always associated with some disease of the bone which causes rarefaction or destruction of the bone, and renders it more liable to break. The following affections often result in spontaneous fractures Paget's disease parathyroid osteodystrophy, fragilitas ossium, secondary malignant disease especially following breast or prostatic tumours bone cysts osteomyelitis and tabes dorsalis

THE SYMPTOMS OF A FRACTURE

1 A careful **history** should be taken concerning the time, site, and details of the injury which caused the fracture, and enquiry should be made as to the presence of any predisposing factor or bone disease

2 **Pain.**—Most fractures cause pain, but the severity of the pain varies with the individual, and the type and position of the fracture The pain is continuous in type and is aggravated by any movement of the limb

3 Palpation of the limb will reveal **tenderness** localised very precisely to the fracture line

4 The pain causes reflex **muscle spasm** which, in itself is painful and leads to **loss of function** of the part.

5 **Deformity** is often present, due to displacement of the fragments of bone The deformity may take the form of shortening of the limb or angulation or rotation of one fragment in relation to the other

6 Movement of the limb may reveal **abnormal mobility** *of the limb at the site of the fracture, and* **crepitus**, *a grating* sensation may be detected at the same time

7 **Swelling and bruising** are invariable accompaniments of a fracture due to the extravasation of blood and serum

8 **X-ray examination** should never be omitted if a fracture is suspected, as it is infallible proof of the presence or absence of a fracture.

COMPLICATIONS OF FRACTURES

1 A fracture may be **compound.** This is a very serious complication, as the fracture is immediately contaminated

fracture It is more common when there is extensive comminution of the bone and is thought to be due to fat droplets entering the lacerated vessels in the marrow Fat emboli form and circulate in the blood stream, finally lodging in the capillaries of the lungs or brain If the lung is affected, the patient develops symptoms resembling pulmonary oedema coughing up large quantities of frothy sputum Treatment should be on similar lines, *i e* venesection, and hypodermic injection of morphia When the emboli lodge in the brain the patient becomes comatose and usually dies

10 **Delirium Tremens** frequently complicates a fracture in an alcoholic subject The deprivation of alcohol and the injury cause the patient to become delirious, noisy, and subject to hallucinations The usual complaint is the presence of numerous bizarre and loathsome animals in the sick room Treatment should consist of placing the patient on the same amount of alcohol as he is accustomed to take. The next day the amount is reduced and a sedative, such as paraldehyde, given Each day the alcohol ration is reduced and the sedative increased as necessary until ultimately the patient reaches a point when he is without alcohol. The dose of sedative is then gradually reduced

11 **Hypostatic Pneumonia** may result in elderly patients unless they are frequently turned in bed

12 **Malunion**—By malunion we mean union of the fragments in bad position which will result in disability later *e g* lateral angulation of a fractured tibia will result in osteoarthritis of the ankle and flat foot.

13 **Defects of Union of the Fracture** (*vide infra*)

14 **Bed-Sores and Plaster Sores**

15 **Crush Syndrome, or Traumatic Oedema.**—Experience gained from the treatment of air raid victims has brought to light the existence of this condition It is associated with injuries involving prolonged compression or extensive crushing of limbs often without evidence of an external wound Such a patient develops an oedema of the limb often associated with blistering of the skin, and a profound degree of shock following preliminary recovery Despite improvement of the general condition with anti shock therapy oliguria supervenes The urine contains albumin and casts and a

exudation into the soft parts, and they may appear during the course of treatment because of the pressure of plaster casts Late nerve palsy may occur because the nerve may be involved in the callus, or it may be stretched because of mal alignment of the limb

5 **Muscle Injuries** may complicate a simple fracture, but usually need no specific treatment. Muscle lesions which are very liable to complicate a fracture are Volkmann's ischaemic contracture and myositis ossificans These conditions are discussed in the chapter concerning "Affections of Muscles

Atrophy will result from disuse unless the muscles are actively exercised during the whole period of treatment of the fracture The modern ambulatory treatment of most fractures with exercise of all muscles of the affected limb from the first day of treatment, makes this complication a rarity

6 **Joint Injuries**—Fractures may involve joints and, unless the reduction of the fracture is perfect, irregularity of the joint surface ensues with the later development of osteo-arthritis. In some cases the fracture may cause fragments of bone to become loose in the joint. These fragments must be removed to prevent joint disability occurring later

7 **Injuries to a Viscus**—Visceral injuries may complicate a fracture as a result of the viscus being damaged by the same factor which caused the fracture, or they may follow laceration by the bony fragments The bladder and urethra are more commonly damaged as a result of a fracture than other viscera

8 **Pulmonary Embolism** may follow the receipt of a fracture and occurs usually about seven to ten days after the injury Its onset is heralded by dyspnoea, pallor collapse, sweating and pain in the chest. The pulse is weak and so rapid that it cannot be counted Death frequently supervenes despite energetic treatment by injection of morphia, oxygen therapy and cardiac stimulants Embolectomy has been successful in a few cases Patients who develop smaller emboli and survive show signs of a localised pneumonia within two or three days of the lodgment of the emboli

9 **Fat Embolism**—Fat embolism may complicate a

blast cells which lay down new cancellous bone until the whole of the callus is replaced by true bone The latter stage takes many months, but the fracture is usually firmly united before the ossification is complete The average periods for firm union of various bones are as follows

Clavicle	4 weeks
Radius and ulna	6–8 weeks
Metacarpals	4 weeks
Femur	12–14 weeks.
Fibula	6 weeks
Os calcis	10–12 weeks
Phalanges	3 weeks
Shaft of humerus	6–8 weeks
Upper and lower ends of humerus	6–8 weeks
Lower third radius	4 weeks
Tibia	8–10 weeks
Tarsus	6–8 weeks
Metatarsals	5–6 weeks

These times are increased with advancing age because the blood supply to the bones is not as good as in younger patients, and the tissues do not regenerate as quickly

Union is estimated by clinical and radiological means



FIG 60.—X ray photograph showing early union of a fracture.

Clinical tests consist of examination of the limb for abnormal mobility at the site of the fracture and for the absence of tenderness—absence of tenderness being a sign in favour of sound union If union is sound X ray examination shows callus bridging the bone lesion and becoming ossified (Fig 60)

pigment derived from the injured muscles known as myohaemoglobin Anuria soon follows associated with a high blood urea and uraemic symptoms, and death invariably occurs between the sixth and eighth days. The syndrome is thought to be due to absorption of toxic substances from the crushed muscles

Patients with severe muscle contusion are given

(i) Copious alkaline fluids to prevent precipitation of pigment in the kidney tubules. 2 drams of sodium bicarbonate are given hourly by mouth.

(ii) Intravenous plasma to counteract the loss of plasma into the injured muscles.

(iii) Complete excision of all dead muscle, thus removing the source of the toxins

The onset of oliguria calls for rapid alkalinisation by administration of 3 per cent sodium citrate or sodium lactate by the intravenous route

Amputation of the affected limb does not appear to influence the course of the condition when it has once developed, and treatment is directed chiefly to the renal lesion.

THE REPAIR OF A FRACTURE

The fracture of a bone inevitably causes rupture of blood vessels in and around the bone, and a haematoma results. This is gradually replaced by vascular granulation tissue, which invades the clot from the ends of both fragments A dense bony network soon pervades the granulation tissue and finally replaces it. This bony tissue is known as callus, that between the periosteum of the fragments being known as the external callus, and that joining the medulla as the internal callus. The intermediate callus is that connecting the cortices of the fragments. (Fig 65)

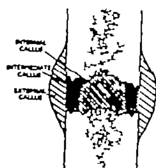


Fig 65—Repair of a fracture.

The callus is finally invaded by osteoclasts, which eat away the calcified tissue. Following in their wake are the osteo-

union by allowing so much movement of the fracture that the new blood vessels in the callus are repeatedly torn and damaged Each injury causes new granulation tissue to form and ultimately fibrosis of the tissue bridging the fracture ensues This prevents any ossification of the tissue and non union results Union fails in fractures due to certain bone diseases, especially when due to secondary neoplasm

The treatment of established non union is directed towards revascularising the ends of the bone fragments This may be done by drilling the fibrosed area in various directions so that new vessels may grow from one fragment to the other In long standing cases, the dense fibrous, sclerosed tissue must be excised and the bone ends freshened at operation The fragments are then opposed and it is usual to bridge them with a bone graft. The latter may be cut from another bone or it may be cut from the same bone and slid down into a groove cut over the fracture (Fig 67) Grafts made of beef bone and ivory are never used to-day as they are foreign bodies which usually lead to a low-grade infection of the bone in which they are implanted

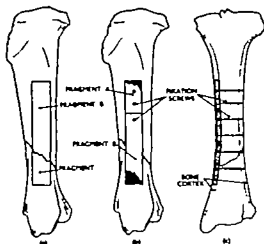


Fig 67 —Diagram to illustrate a sliding bone graft for an ununited fracture of the tibia.

( ) Shows the area of bone cut to make the graft. (b) Shows graft moved downwards (fragment B) to bridge the fracture. (c) Lateral view showing graft fixed in position by Hallam screws.

THE GENERAL TREATMENT OF FRACTURES

First Aid —All fractures should be temporarily immobilised by external splints, often improvised from sticks and umbrellas before the patient is moved from the scene of the accident Splint them where they lie is an axiom

DEFECTS OF UNION

1 **Delayed Union**—If a fractured bone is not firmly united after immobilisation for a period corresponding to the above table, union is said to be delayed The common cause for this is inadequate immobilisation either in duration of the period of immobilisation or incorrect fracture technique. The plaster may be too loose allowing movement of the bone fragments or it may be too short and inadequately im mobilise the fragments These defects of immobilisation cause movements of the fractured ends of the bones, resulting in hyperaemia This causes decalcification of the bone ends, and bony callus does not form as it should If the defect of immobilisation is remedied the hyperaemia disappears and the fracture unites The present-day tendency to use skeletal traction for the reduction of fractures has been blamed as a cause of delayed union, but it is defective technique which causes the delay Over-extension of the fracture, with separation of the fragments, will result in an increase in the time taken for union to become firm whatever the method of traction used but it may be said that over extension is much more easily produced by skeletal traction than by other methods

Infection will delay union and this is commonly seen with compound fractures The toxins from the infected area delay bone and callus formation, and also cause hyperaemia, which promotes decalcification of the bony fragments Recent researches have shown that a lack of Vitamin C is a factor in the production of delayed union because this vitamin has an influence upon the growth and differentiation of granulation tissue and tissue repair

The treatment of delayed union must be directed to removing the cause and immobilising the fracture completely until union is sound. The importance of the latter cannot be over emphasised

2 **Non-union**—Non union is failure of union It may result from the interposition of muscle between the bone fragments, thus obstructing the normal process of repair of the fracture Inadequate immobilisation may cause non

(c) Maintenance of functional activity of all tissues of the limb

Reduction of Fractures—Simple fractures without displacement do not need reduction, and only immobilisation is needed When there is any displacement associated with a fracture reduction is necessary to place the fragments in a satisfactory position for union and for good function after union has occurred Accurate end to-end opposition of the fragments cannot always be obtained, and is not always necessary if the fragments are in apposition and in correct alignment. Good alignment, both longitudinal and rotary is imperative for satisfactory function later Bad alignment leads to osteo-arthritis of joints near the fracture because of the increased strain put on them For the case of fractures involving joints, perfect anatomical reduction is essential if the joint function is to remain as good as it was prior to the fracture, as irregularities lead to instability limitation of movement, and later osteo-arthritis

Reduction should be performed as soon as possible after the fracture occurs, so that the bony landmarks can easily be palpated before they are obscured by reactionary swelling If considerable swelling is present, the plaster should be split immediately after application in order that it can easily be opened by a plaster spreader

Good muscular relaxation is necessary to allow accurate reduction and this must be obtained by means of an anaesthetic. Gas and oxygen or pentothal sodium are the commonest general anaesthetics used. A spinal anaesthetic is excellent for reduction of lower limb fractures whilst a brachial plexus block will give good anaesthesia and relaxation in the upper extremity For the latter anaesthetic, the skin over the clavicle needs surgical preparation The anaesthesia is induced by injecting 20–30 c.c. of 2 per cent. novocaine around the plexus by means of a needle inserted over the middle of the clavicle and directed towards the second dorsal spinous process until the first rib is encountered

Local anaesthesia may be used for the reduction of fractures When using this method the skin of the limb must be given a thorough surgical preparation A

always to be borne in mind The temporary immobilisation minimises the risk of the fracture becoming compound by penetration of the skin by the fragments To be effective, it should immobilise the joints above and below the fractured bone Where the fracture is already compound, no attempt should be made to replace any bone which may protrude through the wound, as this bone is contaminated with clothing and dust and will carry infection with it into the soft tissue

On admission to hospital, the bed should be prepared for the patient by placing a firm mattress over fracture boards. These prevent sagging of the mattress and provide stability for splints used in the process of immobilisation of the fracture. It is an advantage if special fracture beds are available as these beds are provided with sectional mattresses which are a considerable aid to the nursing of the patient.

Clothing should be carefully removed if necessary by splitting the outer seams of the clothing on the injured side. For the upper extremity clothing should be removed from the uninjured side first. The limbs should be protected with bed cradles and nothing further done as regards toilet of the patient until he has been examined by the surgeon.

TREATMENT OF THE FRACTURE

The aim of fracture treatment is to restore the anatomy and physiology of the part to normal. Anatomical restoration consists of restoring the length and shape and alignment of the limb whilst the all important physiological restoration consists in the restoration of the function of the limb to normal One cannot be divorced from the other if success is to be achieved

Three cardinal principles govern fracture treatment

(a) Reduction of the fracture By this we mean correction of any displacement of the fragments

(b) Immobilisation The fracture must be adequately immobilised to prevent re-displacement of the fracture and to allow union to occur

The traction may be exerted by means of skin traction or skeletal traction the latter being preferred by some surgeons as direct traction is exerted on the bone and muscle attachments

Some fractures can only be treated satisfactorily by open operation for example certain fractures of the patella and olecranon In addition open operation may be needed to adequately immobilise the fragments as in fractured neck of the femur Operative reduction of fractures of the long bones is only indicated when other methods fail, or when instability and re-displacement cannot be prevented by external fixation

The disadvantage of open operation is that the fracture is rendered compound and there is the risk of introducing sepsis Further there is often extensive stripping of the periosteum and soft tissues at operation which may damage the blood supply of the fragments sufficiently to cause delayed union

Open reduction is usually delayed for a few days until the swelling and ecchymosis has subsided It must be delayed until any skin abrasion has completely healed if sepsis is to be eliminated Simple apposition of the fragments is often sufficient to maintain stable reduction However if the fracture is unstable, internal fixation is used This may take the form of a bone graft or vitallium plate or screw When using plates and screws the fracture is held in the reduced position by a Lowman clamp and the bone drilled for the screws The drill size should be the same as the root size of the screw Further the screws should not be of the tapering variety but should have a uniform diameter and be threaded up to the head They should engage both cortices of the bone

It is important to bear in mind that this internal fixation is merely a means of holding the fragments in good position and is not sufficient to immobilise the bone External fixation by plaster or traction and splint is just as essential as for a closed reduction

Immobilisation of a Fracture —To-day plaster of Paris is used extensively as a means of immobilisation of fractures as it gives excellent fixation and its rigidity allows fractures of the lower limb to be ambulatory Certain splints are also used in combination with traction such as the Braun and Thomas splints Some fractures are stable when the limb is placed in a certain position so that a muscle aids immobilisa

hypodermic needle is inserted into the fracture line, this being demonstrated by the aspiration of blood when the needle is in the fracture haematoma 20 c.c. of 2 per cent. novocaine are then injected into the haematoma. The anaesthesia is so good that it may be really a disadvantage because the patient may inadvertently move the limb and render the fracture compound Further when manual traction is being used, the absence of pain enables the patient to resist the traction force, and manipulation is difficult. A serious disadvantage of local anaesthesia is the risk of the introduction of infection into the fracture haematoma when giving the anaesthetic, but such a mishap is an indication of the neglect of elementary aseptic technique

The methods of obtaining reduction vary with the type of fracture and the bone affected Closed manipulation is used for fractures which do not readily redisplace after manipulation Common examples of this are seen in a Pott s fracture and a Colles fracture (*vide infra*) The method consists essentially of manual traction to separate the fragments and then manipulation of one fragment into alignment and apposition with the other With greenstick fractures the bone must be completely fractured before satisfactory alignment can be restored

Where the fracture is mechanically unstable and there is overlapping of the fragments—for example in the case of oblique and spiral fractures, or where large powerful muscles are maintaining displacement of the fragments, as in a fractured shaft of the femur—reduction must be obtained and maintained by traction This method depends upon the fact that the muscle attachments to the bone and the periosteum align the fragments Traction needs either a fixed point from which it can be exerted this being called fixed traction or an equal counter-extension may be applied giving balanced traction

Fixed traction is used when a Thomas splint is used for a fracture of the femur when the extension tapes are tied to the end of the splint, the fixed point being the ischial tuberosity The simplest type of balanced traction is weight and pulley extension, using the body weight as counter traction. Combinations of both types of extension may be used

can the necessary psychological outlook which promotes full recovery, be instilled into many of these patients In such a department the patient is encouraged by seeing others who have similar injuries using their injured members Thus all become imbued with a desire to get well again as quickly as possible

Every member of the rehabilitation team should endeavour to create an atmosphere of encouragement and cheerfulness from the moment the patient enters hospital for rehabilitation really commences then The aim of physical treatment is to improve muscle control as function and stability are entirely dependent upon adequate muscle power

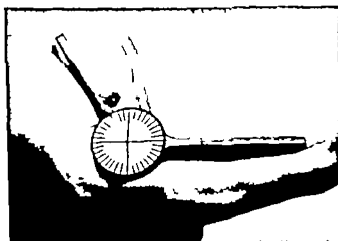


FIG 08 —A goniometer is used to measure the range of joint movement

and co-ordination One should continually strive to develop this by the patient's *own* efforts guided by the physiotherapist thus reserving passive therapy for the minority

Methods used for the physical treatment during rehabilitation are as follows

1 *Passive Physiotherapy* means massage heat and electrotherapy From the patient's point of view this is a very comfortable and less strenuous method Such treatment is reduced to a minimum so making him depend more on his own efforts than those of others It should be used in small doses as a preliminary to remedial exercises Wax baths however are valuable as a prelude to exercises for stiff joints

2 *Remedial Exercises* —Usually two periods of remedial

tion, *e g* immobilisation of a supracondylar fracture by placing the elbow in flexion The fracture is then stable as the triceps muscle splints the fracture posteriorly One fracture, that of the neck of the femur needs internal fixation with a Smith Petersen pin to give good immobilisation Other methods cannot immobilise the small upper fragment

Restoration and Maintenance of Functional Activity — To obtain excellent anatomical reduction of a fracture without the functional activity of the limb is wasted energy It must be remembered that a fracture is not simply an injury to a bone it is an injury to the tissues around that bone and the limb as a whole The functional activity of these tissues can only be maintained by use and by fixing the joints near the fracture in the optimum position for activity Exercises for the muscles of the limb should be performed immediately after reduction and continued daily until treatment is discontinued For example in the lower limb we allow patients to walk in their plaster casts and endeavour to produce natural walking movement so that the patient s attention is distracted from the bone injury and full use is made of muscles which are normally used for walking Toe movements are practised daily to main tain the tone of the calf muscles Patients are encouraged to try to move the joints which are immobilised, thus con tracting their muscles isometrically *i e* without any shorten ing of the muscle and so maintaining the tone of these muscles With the arm finger movements are insisted upon from the first day of treatment, and the patient is encouraged to use the limb when the method of immobilisa tion allows The use of the muscles reduces the swelling and prevents joint stiffness so that the function of the part is good when the immobilisation is removed (Fig 68)

Occupational therapy is a valuable means of encouraging the patient to use his injured limb (remedial therapy) and it diverts his attention from the injury (diversional therapy) It is essential for the full and rapid recovery of injured persons that they should spend the day performing exercises and engaging in occupational therapy periods of rest *being* interspersed This for ambulant patients means attend ance at a rehabilitation department Only by this means

can the necessary psychological outlook, which promotes full recovery be instilled into many of these patients In such a department the patient is encouraged by seeing others who have similar injuries using their injured members Thus all become imbued with a desire to get well again as quickly as possible

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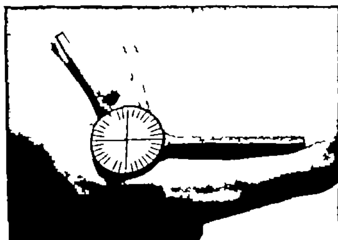


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2 *Remedial Exercises* —Usually two periods of remedial

exercises are given daily each lasting approximately half an hour Three types of such exercises are used

(a) Resisted movements
(b) Active free swinging movements
(c) Assisted movements

(a) Resisted movements are designed to improve the function of groups of muscles In practice, they consist of weight and pulley and spring exercises and active muscle contractions (static contractions) where the joints are fixed by antagonistic muscles or by plaster casts The performance of static contractions is one of the most useful methods of developing muscle power

(b) The aim of active free swinging movements is to improve the mobility of joints and general muscle tone and co-ordination, and may take the form of specific exercises for the disability and part injured or general body exercises

(c) Assisted exercises are valuable for shoulder and knee injuries and consist of assisting a weak movement by means of the pull of the opposite limb using a pulley circuit

At the commencement of a course of remedial exercises, strain and resistance must be removed from the weakened muscle by elimination of gravity This may be obtained by posture or by supporting the limb or trunk by slings in such a position that the force of gravity has not to be over come by the muscle under treatment, *e g* for the deltoid muscle the patient lies supine with the arm externally rotated As improvement is obtained, the force of gravity is used as a resistance

3 *Organised games* such as netball cycling and bowls, are useful for distracting the patient s attention from his injured part whilst using it, thus allowing greater activity of the part and encouraging the competitive spirit

4 All patients should be given *postural and walking exercises* and any tendency to the development of a limp eradicated Instruction and practice of the movements of walking are given to bed cases so that better gait is assured

when weight bearing is allowed For lower limb injuries crutches or sticks should be allowed at first to give confidence and aid correct walking When sticks are used two sticks should always be provided The patient should never be allowed to walk with one stick as this will lead to the development of a limping gait

5 *General Bed Exercises* —All bed patients whose condition will allow should undertake general bed exercises These consist of breathing exercises and others designed to maintain the normal posture and tone of the abdominal and limb muscles

THE TREATMENT OF A COMPOUND FRACTURE

First Aid —If bleeding from the wound is severe a tourniquet may have to be applied to control it. The limb must be immobilised by improvised splints but no attempt must be made to replace any protruding bones

In hospital it is essential that the nurse should search for and report the presence of a tourniquet All sufferers from compound fractures should receive a prophylactic injection of antitetanic serum (3000 units being administered) and antigas gangrene antitoxin (9000 units) as the wound is often contaminated with dust and soil which may contain spores of tetanus and organisms which produce gas gangrene

It will be found that a considerable degree of surgical shock is usually present, and this must be combated before any special attention is paid to the reduction and immobilisation of the fracture Haemorrhage from the wound should be controlled by the application of a pressure bandage. The patient should be kept warm by hot water bottles and blankets or a radiant heat shock cage, but the nurse must be careful that overheating and sweating is not produced or the shock will become more profound The foot of the bed should be raised 10–14 in in order to drain the blood from the limb and so conserve it for circulation through the vital organs

A hypodermic injection of morphia will usually be ordered by the surgeon to allay the pain, and an intravenous blood or plasma transfusion may be necessary

When the patient's general condition permits he is taken to the operating theatre for treatment of the local injury A gas and-oxygen or pentothal anaesthetic is usually given as this is less likely to increase the shock than other anaesthetics

When the patient is anaesthetised the wound is covered with sterile gauze, the limb washed, shaved, and prepared with methylated ether and finally surgical spirit or mercurochrome

The surgical team then change their gloves and gowns and the limb and table are draped with sterile towels No tourniquet is used as the surgeon will wish to see whether the tissues bleed when incised thus detecting their viability The wound is cleansed with hydrogen peroxide after which the wound edges and contaminated tissues are excised The wound is excised until free bleeding is obtained from the cut muscle, the latter denoting healthy tissue Bleeding vessels are ligatured and cut nerves sutured loosely to anchor the segments and prevent retraction or displacement One of the sulphonamide powders is then insufflated into the wound, either sulphanilamide or sulphathiazole Recently proflavine and penicillin powder has been used in addition If all the dead and contaminated tissue together with all foreign bodies have been removed within four to six hours of the receipt of the injury then the skin is sutured over the wound The sutures should be under no tension If this is unavoidable then an immediate skin grafting is preferable The fracture is then reduced and a well padded plaster applied but absolute accuracy of reduction is not an immediate necessity Perfect reduction is obtained later when swelling and all danger of spread of infection are remote

Cases seen after six hours are very likely to be infected, and are regarded as such These and cases in which complete excision of the wound is impossible should not be sutured but should be treated by lightly packing with sterile vaseline gauze Counter incisions may be necessary for drainage The fracture is then reduced by the same methods as if it were a simple fracture the wound being enclosed in a padded plaster No window is cut over the wound as this would allow oedema because of the lack of support by the plaster Painful oft repeated dressings are thus avoided but the

plaster-cast is split to allow rapid "spreading" if any swelling endangers the circulation of the limb

After treatment is the same as for a simple fracture bearing in mind the fact that the wound is infected and that union will be delayed An oral course of sulphathiazole is usually given to control the infection one gram (2 tablets) being given four hourly for three days in the case of an adult and half this dose for a child Recent experience with war injuries reveals that intra muscular injections of penicillin are invaluable for control of the wound infection and prophylaxis of gas gangrene The plaster is changed to a skin tight plaster after three to four weeks the fracture being accurately reduced at the same time Secondary suture or skin grafting of the wound is undertaken as soon as the infection is controlled

If the limb is so badly crushed and lacerated as to be a useless organ or if the whole blood supply is destroyed an amputation will be necessary

SPECIAL COMPLICATIONS OF COMPOUND FRACTURE

1 **Inadequate Drainage** —This complication is indicated by the presence of a persistent swinging temperature associated with a rapid pulse and pain in the limb Further drainage is necessary and the patient must be submitted to further operative measures to provide this

2 **Secondary haemorrhage,** due to infection causing erosion of a vein or artery This complication usually develops about seven to twelve days after the injury and is usually severe Treatment consists of temporary arrest of the bleeding by packing the wound and providing better drainage A blood transfusion is usually given These measures may be sufficient to produce permanent stoppage of the haemorrhage Often ligation of the proximal and distal ends of the bleeding vessel is necessary after the wound has been enlarged

3 **Gas-Gangrene** —Gas gangrene is a condition of spreading infective gangrene caused by the spore bearing gas producing organisms which are carried into the wounds The

commonest of these which lead to gas gangrene are the Bacillus Welchii and the Bacillus Oedematiens

The condition is characterised by the onset of a profound toxaemia associated with a rising temperature and pulse-rate, an ashen grey pallor and a marked change in the mental attitude of the patient There is a serous discharge from the wound, which has a peculiar pungent odour The tissues of the limb are swollen, necrotic, and oedematous and will crepitate on palpation due to the gas produced by the infection An X ray examination will reveal air bubbles between the muscles It is to be emphasised that the presence of gas in an injured limb does not necessarily indicate the presence of gas gangrene *Treatment* consists of immediate extensive drainage of the wound and infected area, cutting away all diseased tissue and the administration of 60 000–100 000 units antigas gangrene serum and full doses of sulphathiazole 50 000 units of penicillin are administered parenterally and an optimum concentration maintained in the blood stream by intramuscular injection of 15 000 units every three hours Further doses of serum are given, and a blood transfusion of one to two pints of blood is given by the drip method If the gangrene continues to spread despite treatment, an amputation above the upper limit of the infection will be necessary to save life

X ray therapy has been used for the treatment of gas gangrene particularly in the United States where considerable success has been claimed for this method It has never been popular in this country

4 **Tetanus** —Tetanus results from infection with Bacillus Tetanus Penetrating and grossly contaminated wounds where dead tissue is present and drainage and oxygenation of the wound is poor are frequently contaminated with this organism It is usually prevented by thorough wound excision and drainage and the prophylactic administration of antitetanic serum

The first indication of the onset of tetanus is the appearance of twitching around the mouth followed by spasms of the muscles of the jaw and face The spasms rapidly become generalised and painful producing opisthotonus Persistence of the spasms and toxaemia causes exhaustion and death

Treatment is directed to

(a) Neutralisation of the toxins by intravenous administration of large doses of antitoxin

(b) Relief of spasms by sedatives Often basal anaesthetics such as paraldehyde or avertin are necessary

(c) Maintenance of nutrition by regular concentrated liquid feeds Usually these have to be given by a stomach tube under anaesthesia to avoid initiating the muscle spasms

5 **Traumatic Arterial Spasm** —Traumatic arterial spasm may complicate a simple fracture as a result of contusion of the main artery to the limb but it is a more common accompaniment of a compound fracture Afferent impulses originating from the injured segment of the artery reflexly produce spasm of the whole of the affected artery and the vessels of the collateral circulation The condition is characterised by loss of pulsation of the arteries together with paraesthesia and pallor of the limb Failure to relieve the spasm may result in gangrene or Volkmann s ischaemic contracture

Treatment is directed to breaking the reflex arc and producing vasodilatation of the collateral circulation This may be effected by excision of the injured segment of the artery (arteriectomy) or by sympathectomy or by paravertebral blocking of the sympathetic ganglionic chain with a local anaesthetic. The limb should be kept cool by allowing it to be exposed and placing ice bags in its immediate vicinity The aim of this procedure is to reduce the metabolism of the part and so decrease the need for oxygen, and to minimise bacterial growth The remainder of the body should be warmed in an effort to produce a reflex vasodilatation in the affected limb and so improve the collateral circulation

FRACTURES OF INDIVIDUAL BONES

THE MANDIBLE

Fractures of the lower jaw are usually due to direct violence and occur chiefly at the junction of the anterior third of the ramus with the posterior two-thirds The other common site is the lower part of the ascending ramus The former fracture is usually compound with the wound inside

the mouth, because the mucoperiosteum of the jaw is firmly adherent to the bone. Displacement of the fragments is usual. The patient's mouth is fixed in a semi-open position because of muscle spasm, and blood and saliva are seen dripping from the mouth. If the inside of the mouth is examined one sees an irregularity of the teeth at the site of the fracture in the anterior type only. The first aid treatment consists of the application of a firm bandage passing under the jaw and tied over the vertex of the skull, thus supporting the jaw and the maintenance of a good airway by preventing the tongue falling backwards. The four tail bandage should not be used, as this will increase the backward displacement of the fracture. Reduction and fixation should be carried out as soon as possible to prevent the mouth becoming foul and infected because of stasis of secretions inside the mouth. The latter is due to painful muscle spasm limiting any movement of the jaw or the tongue. The aid of a dentist is enlisted for ensuring fixation of the fracture. Reduction is carried out under general anaesthesia, the fragments being fixed either by wiring the teeth of both jaws together or by dental splints. Any infected teeth are extracted to reduce the risk of infection. The fixation is made to ensure the correct apposition of the teeth when biting. When the jaw is edentulous, external pin fixation may be used, or the fragments wired to vulcanite splints. After-treatment consists of adequate and frequent cleansing of the mouth with antiseptic mouth washes. When the two jaws are fixed together the patient may be fed by introducing minced foods and liquids into the buccal sulcus.

Complications which may supervene are septic bronchopneumonia from aspiration of secretion, osteomyelitis of the jaw, cellulitis of the neck and mediastinitis.

FRACTURES OF THE UPPER LIMB

THE CLAVICLE

Fractures of the clavicle usually occur in the middle third of the bone and are due to a fall on the outstretched hand, *i.e.* as a result of indirect violence. The weight of the arm pulls the outer fragment downwards, inwards and

forwards whilst the inner one is pulled upwards by the sterno-mastoid muscle Thus to reduce the fracture, the



Fig 69 — Figure of eight bandage for immobilisation of a fractured clavicle

Note the steel rod placed in the crooks of the elbow to maintain reduction while the bandage is being applied.



Fig 70 — The three-sling or ring method for immobilising a fractured clavicle.

The rings are made from strips of lint 6 in wide These are rolled into tubes and packed with wool. The edges are then stitched together to form ring. One ring is slipped over each shoulder and fixed posteriorly by the third ring" or sling. The arm is supported by a sling.

arm must be elevated and the shoulder pulled backwards to bring the outer fragment into line with the inner fragment Numerous methods are advocated to achieve this

The simplest method is a figure-of eight bandage round the axilla (Fig 69) crossing posteriorly so as to pull the shoulders backward Large pads of wool are placed in front of each shoulder before the bandage is applied so as to relieve any pressure on the axillary vessels and nerves The bandage should be firm but care should be taken not to obstruct the blood supply to the arm The arm of the affected side is then supported by a sling Finger



Fig. 71 — Posterior view of Fig 70 showing fixation of rings by third sling

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Fig 71 — Posterior view of Fig 70 showing fixation of rings by third sling

the axilla Reduction may be obtained by locking the fragments in position by adducting the arm across the body and pressing outwards over the fracture. The arm is then bandaged to the chest with a pad of wool placed in the axilla. If this reduction is not stable the fracture may be reduced by a Böhler arm screw traction frame and the limb placed on a continuous traction abduction frame using continuous skin traction or skeletal traction by means of a Kirschner wire inserted through the olecranon process of the ulna. (Fig 73)

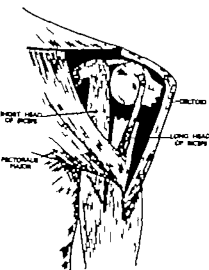


Fig 73 —Non impacted fracture of the surgical neck of the humerus, showing displacement, which occurs in the minority of cases.

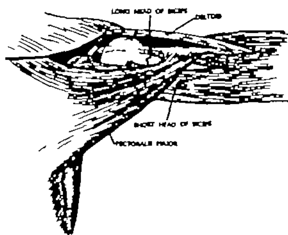


Fig 73A.—The position of abduction with traction is necessary to bring the distal fragment into alignment with the short proximal fragment.

Union is usually firm enough to cease traction after four weeks Shoulder movements on the abduction frame are then commenced, and the frame discarded when *full* abduction can be maintained

Adduction fractures are reduced by manual traction on the arm in abduction and then immobilisation on an abduction frame for four weeks After treatment is the same as for abduction fractures

(*b*) **Fractures of the greater tuberosity** (Fig 74) are treated by fixing the arm on an abduction frame this position bringing the shaft of the humerus to the displaced fragment of the tuberosity which is pulled upwards by the supraspinatus muscle

(c) **In children** the epiphysis of the head of the humerus may be separated and displaced in a similar manner to the

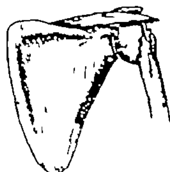


Fig 74.—Fracture of the greater tuberosity showing the displacement caused by contraction of the supra spinatus muscle

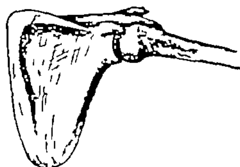


Fig 74a.—Position of abduction usually necessary to align the fragments.

above-mentioned injuries Treatment is along similar lines and open operation to reduce any slight displacement which cannot be rectified is to be avoided as the epiphysis will

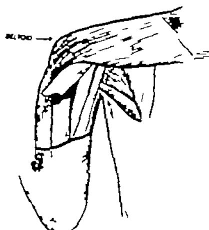


Fig 75.—Fracture of the humerus below the insertion of the deltoid muscle The abducted position of the proximal fragment is due to contraction of the deltoid.

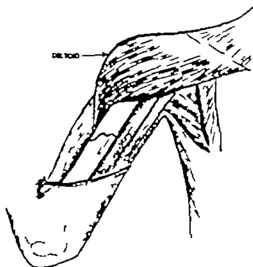


Fig 75a.—Position generally required to bring the fragments into alignment.

remould so that in a few years time the deformity will be non-existent

(d) **Fractures of the shaft of the humerus** are usually due

to direct violence and are transverse in type If displacement is present and the fracture is between the insertions of the pectoralis major muscle and the deltoid muscle, the upper fragment is adducted by the former muscle and the lower one is abducted and pulled upwards by the deltoid muscle



FIG 76 —Lateral traction applied to the humerus with the arm resting on a Thomas arm splint. The method is used for certain fractures of the humerus, fracture-dislocation of the shoulder and fractures of the clavicle.

If the fracture is below the insertion of the deltoid the upper fragment is abducted by the deltoid and the lower fragment is displaced upwards and inwards by the pull of the biceps and triceps muscles (Fig 75) Reduction of the former is obtained by adduction of the arm across the chest and fixation in that position The other fractures are reduced by bringing the lower fragment into line with the smaller uncontrolled fragment by means of fixing on an abduction frame or plaster spica (see Fig 80) with the arm abducted 40 –50 The immobilisation is maintained for at least six weeks before radiographs for union are taken Fractures of the shaft of the humerus are often followed by delayed union or non union which is usually due to ineffective immobilisation or to interposition of muscle

Another complication to which these fractures are liable is *injury to the musculo-spiral nerve* which rests upon the bone in the musculo-spiral groove on the posterior aspect of the middle third of the humerus The nerve may be torn at the time of injury by the traumatising agent, or by the fragments themselves, or during reduction or by involvement in callus later

(c) **Fractures of the lower third of the humerus** —A brief résumé of the surgical anatomy of the lower end of the humerus will help to elucidate some important factors in the treatment of fractures in this region

The lower part of the humerus broadens out and becomes flattened from before backwards, terminating in the medial and lateral epicondyles Between these epicondyles lie the olecranon and coronoid fossae which accommodate the processes of the ulna, so named during extremes of flexion and extension of the elbow A fracture involving these fossae may result in thickening of the bone there and thereby limit flexion or extension of the elbow

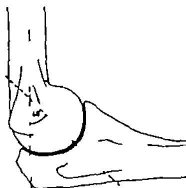


Fig 77 —The lower end of the humerus is tilted forwards 40 This must be restored in fractures involving this region if full flexion and extension is to be preserved

The articular surfaces of the lower end of the humerus lie below the fossae and epicondyles They are angulated forwards, making an angle of 40 with the shaft of the humerus (Fig 77) The articular surface is divided into two parts, *i e* the rounded capitellum which articulates with the radius and the trochlea which articulates with the ulna The latter is facing medially on its inferior aspect but much less so on its anterior aspect The

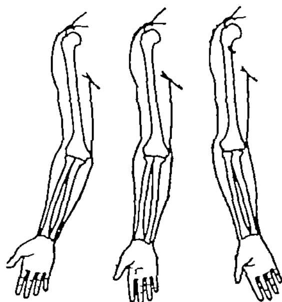


Fig 78 —Cubitus valgus and cubitus varus. Normal " carrying-angle shown in the centre

result is that the forearm is angulated laterally on the humerus approximately 10°–15 when the arm is extended this being known as the carrying angle. Full flexion of the elbow causes this to disappear (Fig 78) This angle may be altered in fractures of the lower end of the humerus producing cubitus varus or valgus Restoration of the normal carrying angle is essential in the treatment of elbow fractures if normal elbow function is to be restored

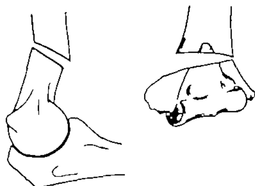


FIG 79—Supracondylar fracture showing typical posterior and lateral displacement

Fractures of the lower end of the humerus are often through the bone just above the epicondyles, and are usually found in children (Fig 79) Such a *supracondylar fracture* is due to a fall on the outstretched hand when the lower fragment is usually displaced backwards and rotated laterally It is reduced by manipulation and immobilisation of the arm by flexing and supinating the forearm and fixing with a collar and cuff (Fig 80) There is usually considerable swelling associated with supracondylar fractures, and the degree of flexion should be reduced if the swelling is marked *The pulse must be palpable and the degree of flexion reduced until a good pulse is present* The patient should preferably be treated as an in patient, where the nurse must maintain careful watch on the volume of the pulse of the affected side, and on the condition of the fingers Any variation of the pulse volume or any numbness or tingling in the fingers, should be communicated to the surgeon immediately or ischaemia of the muscles may follow resulting



FIG 80—"Collar and cuff" applied for injuries about the elbow joint The arm is usually flexed more than in the photograph.

in Volkmann's ischaemic contracture (*vide infra*) (Fig 81) The immobilisation is maintained for three weeks and then active elbow movements commenced

The *medial epicondyle* is occasionally torn off by violence, causing abduction of the elbow Manual reduction may be obtained by flexing and supinating the elbow but often the fragment with the origin of the flexor muscles of the hand and wrist attached, has to be sutured into place by open operation Screw fixation is unnecessary suture of the periosteum being sufficient. The arm is then immobilised as for a supracondylar fracture, for three weeks and then active exercises commenced If reduction is not obtained the carrying angle will be increased and traction and irritation of the ulnar nerve as it passes behind the medial epicondyle will result, producing traumatic ulnar neuritis



FIG 81 —Elevation and suspension of the arm to reduce oedema following fractures of the upper extremity

FRACTURE OF THE OLECRANON PROCESS OF THE ULNA

A fracture of the olecranon process is due to direct violence The smaller proximal fragment is almost always pulled up by the triceps which is inserted into it, resulting in considerable displacement The treatment of such a fracture entails open reduction and fixation of the fragments This is undertaken 3–4 days after the injury provided there

are no skin abrasions If these are present, operation must be delayed until they are healed, or infection of the wound and the fracture may ensue The operation consists of fixation of the fragments together with chromicised catgut taking care to accurately reproduce the normal alignment of the joint surface The elbow is then immobilised by a plaster-cast, extending from the upper one-third of the humerus to the metacarpo-phalangeal joints the elbow being fixed in 90 flexion and mid pronation The cast is removed at the end of four weeks and union tested It should be firm Then active elbow exercises are commenced.

A more recent procedure, which obviates the necessity for accurate replacement of the joint surface is excision of the separated fragment and suture of the triceps muscle and its expansion to the ulna and its periosteum. A further advantage of this method of treatment is that only 12–14 days immobilisation in plaster of Paris, with the arm extended is needed before full active elbow movements can be commenced Full movements of the elbow are obtained just as with fixation of the fragments If no displacement is present in the original fracture the arm is immobilised for four weeks with the elbow extended

FRACTURES OF THE HEAD OF THE RADIUS

Fractures of the head of the radius are due to a fall on the extended wrist, with the forearm fully pronated The violence is then transmitted through the shaft of the radius and the head of the radius is driven against the capitellum resulting in a fissured fracture or comminution of the head of the radius Fragments may be separated and lie free in the elbow joint. The patient experiences pain over the head of the radius and elbow movement is restricted

The treatment of the fissure fracture, and fractures which are not displaced or separated consists in immobilisation of the elbow in flexion with a collar and cuff for fourteen days *A careful watch is maintained on the pulse volume and on the circulation of the fingers* as in supracondylar fractures Active elbow exercises are then commenced the arm being

placed in a sling initially The degree of extension allowed by the sling is daily increased and discarded when extension to 90 is obtained

If the fracture is comminuted or where the fragments are displaced an open operation is necessary to excise the head of the radius These fractures are not treated conservatively as the articular surface is so badly damaged that osteoarthritis would result if it were left *in situ* After the head is excised the arm is held flexed by a collar and cuff until removal of the sutures at the tenth day Active elbow movements are then commenced

A word of warning concerning the careful after treatment of all elbow injuries is included here because many stiff elbows result from injudicious treatment at this stage Passive movements, stretchings massage and the carrying of weights are mentioned only to be strongly condemned These measures cause repeated reactionary exudation around the joint, new adhesions form and so increase the stiffness They also aid the development of myositis ossificans, which, when it occurs, will increase the stiffness The patient's own active movements are all that are necessary to restore function

FRACTURES OF THE SHAFT OF THE RADIUS AND ULNA

Movement of the forearm on the arm is largely concerned with the ulna whilst movement of the hand and wrist is largely concerned with the radius The hand and the radius move in a plane at right angles to the shaft of the ulna when supination and pronation occur This rotation occurs at the superior and inferior radio ulnar joint about an axis passing through the head of the radius and the ulnar styloid process the normal range of movement being 160°–170

The pronator muscles are the pronator teres, which pass from the medial epicondyle of the humerus to the middle of the shaft of the radius, and the pronator quadratus which passes between the volar aspects of the lower ends of the radius and ulna

The movement of supination is brought about by the biceps and the supinator brevis the latter arising from the upper part of the ulna and passing to the posterior and lateral aspects of the upper end of the radius

When fractures of the shafts of the radius and ulna occur the upper radial fragment is pulled by the biceps and pronator teres into a flexed position and by the latter muscle towards the ulna Thus to bring the lower fragment into alignment with the upper the forearm must be semi pronated and flexed on the arm at 90 If the fracture is above the insertion of the pronator teres, the upper fragment is supinated and the arm must be supinated to obtain reduction

Fractures of the shafts of both bones of the forearm are



FIG 82.—Traction applied for fractures of the forearm

due to direct violence and there is usually displacement of the fragments, with some shortening and overlapping of the bones

Treatment of undisplaced fractures consists of immobilisation in a plaster of Paris cast extending from the metacarpo phalangeal joints of the hand to the middle of the arm with the elbow *flexed 90* and *held midway between pronation* and supination

Displaced fractures are treated by manual traction and manipulation and are immobilised in the same manner as the fractures with no displacement, but in the position indicated by the site of the fracture (Fig 82) Finger movements are practised daily and the patient is encouraged to use the arm. The plaster-cast is removed after six weeks, and if union is firm full active movements of the limb are begun

COLLES FRACTURE

Colles fracture is so named after Abraham Colles, who first described it in 1814 It is due to a fall on the outstretched hand with the wrist dorsi flexed The radius fractures approximately one inch above the wrist joint, and the ulnar

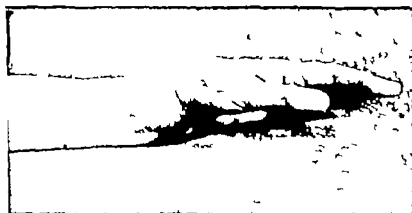


Fig 83 —Colles fracture showing the typical "dinner fork" deformity due to backward displacement and tilting of the lower fragment.

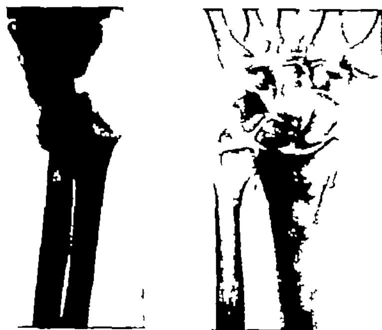


Fig 84 —X ray photograph of Colles fracture

styloid process is avulsed or the ulnar collateral ligament torn The small distal radial fragment is displaced backwards and radially and rotated backwards and supinated causing the typical dinner fork deformity of the wrist (Fig 83) Impaction of the fragments is usual (Fig 84)



FIG 85 —Plaster for a Colles fracture. The shape is cut from plaster fabric or bandage 10 in wide. Eight layers are used. The piece cut away from the thumb is 3 in long 6 in to 7 in deep.



FIG 86 —Application of plaster for Colles fracture

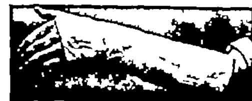


FIG 87 —Plaster for Colles fracture. Note the extent of the cast. A moist cotton bandage is applied until the plaster is set.

Treatment consists of manipulative reduction and immobilisation in a plaster cast extending from the knuckles posteriorly and the distal palmar skin crease *i.e* the metacarpo-phalangeal joints to the elbow the thumb being left free. (Figs 85 86 and 87) The wrist is immobilised in neutral position midway between flexion and extension and in ulnar deviation, the arm being fixed in full pronation Flexion of the wrist is unnecessary to immobilise the fragments, and will prevent active use of the fingers Full use of the fingers and arm must be insisted upon immediately The plaster is removed at the end of four weeks and full use of the arm encouraged by exercises The patient is usually fit for work within 10–14 days after removal of the plaster

FRACTURED CARPAL SCAPHOID

Fracture of the carpal scaphoid is due to a fall on the dorsi flexed wrist the violence shearing off the lateral part of the bone which is unsupported by the radius The patient complains of pain and swelling just distal to the lower end of the radius, over a depression known as the "anatomical snuff box" Wrist movements are painful and restricted Some cases are often mis-diagnosed as sprains of the wrist, and considerable disability will result if untreated

The fractures are treated by immobilisation in a plaster cast extending from the metacarpo-phalangeal joints to the elbow including the thumb with the wrist fully dorsi flexed and radially deviated (Fig 88) General anaesthesia is often needed to obtain this position before the plaster is applied Finger exercises and use of the arm are commenced immediately The cast is not removed before the end of the third month after which X rays are taken to detect union If union is not firm further immobilisation in plaster is necessary until union is absolutely firm When this stage is reached active movements of the wrist are commenced



Fig 88 —Plaster applied to fracture of the carpal scaphoid The wrist is dorsiflexed and deviated radially while the thumb is fixed in semi-opposition.

Ununited fractures are usually treated by bone grafting

FRACTURED METACARPALS AND PHALANGES

Fractures of the metacarpals and phalanges may follow the application of direct or indirect violence

Metacarpals —Fractures of the shaft of the metacarpals are treated by immobilisation on a Bohler finger splint

(Fig 89) the splint being fixed to the hand and wrist by a plaster-cast. The finger corresponding to the affected metacarpal is strapped to the splint with the metacarpo-phalangeal joint flexed 45 the proximal interphalangeal joint flexed 90 and the distal interphalangeal joint flexed 45 In this position the collateral ligaments of the joint are just taut Thus contractures which result in stiffness of the fingers are avoided

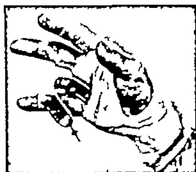


Fig 89 —Böhler finger splint applied for a fractured phalanx Note that the other fingers are quite free and full movements are possible.

If angulation of the fracture is present, reduction can be obtained by traction exerted through a pulp traction pin, the pin passing through the pulp of the distal phalanx, with the finger immobilised as above

With **Bennett's fracture-dislocation** of the base of the metacarpal of the thumb the distal large fragment is displaced proximally (Fig 90) It can only be reduced by continuous pulp traction aided by full abduction of the thumb and immobilisation of the thumb and wrist in plaster of Paris Immobilisation for three weeks is nécessary for all closed metacarpal fractures

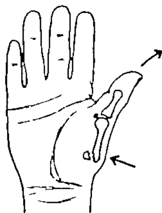


Fig 90 —Bennett's fracture-dislocation of the thumb.

Phalanges —Fractures of the middle of the phalanges are usually angulated because the interossei and lumbrical muscles flex the proximal and extend the distal fragments by virtue of their course from the volar aspect of the hand to the dorsal aspects of the fingers This angulation is reduced by continuous pulp traction with the finger immobilised on a Böhler finger splint Accurate reduction is essential to later function as the volar aspects of the phalanges form the floor of the flexor tendon tunnels

With all finger and metacarpal injuries the fingers must be immobilised in flexion as described above if stiffness is to be avoided and reduction is to be satisfactory Only the injured fingers are immobilised and full finger exercises must be practised daily with the other fingers *Compound fractures of the fingers* need special care and patients should be always treated as in patients The wound toilet should be performed in a fully equipped operating theatre, the whole procedure being regarded as a major operation Conservatism should be the keynote of treatment because of the economic importance of the fingers *The thumb is conserved at all costs* even if it becomes a rigid digit, because the function of the hand is reduced by 50 per cent if the thumb is lost. Degloved digits need immediate covering with skin, using flaps or tunnels from the abdomen

FRACTURED RIBS

Fractures of the ribs are usually due to violence applied in an antero posterior direction Such compression of the thorax causes lateral pressure on the lateral aspects of the chest, producing fractures of the rib in that situation Direct violence may fracture ribs driving the fragments inwards with damage to the underlying pleura and lung The chief disability which patients complain of is difficulty with respiration This is due to the pain which results from movement of the fractured ribs during respiration The pain reflexly inhibits respiration and a congestive type of pneumonia may follow Treatment is designed to relieve the pain and so prevent pulmonary complications Union or non union of the fracture is of no consequence The most effective method of treatment is novocaine injection of the fracture followed by breathing exercises The injection may need to be repeated on two or three occasions at twelve hourly intervals before the pain is completely relieved Ambulatory treatment should be pursued if possible but if the patient has to be confined to bed because of other injuries or because of his general condition expansion of the lungs must be obtained by inhalation of

5 per cent carbon dioxide in oxygen for ten minutes every hour for the first twenty four hours and by frequently moving the patient in bed Uncomplicated cases can return to work within ten days

Some surgeons prefer to immobilise the chest with adhesive strapping When this is used it is imperative that the strapping be non elastic that it encircles the whole of the chest, and that it be placed over the lower costal margins and not necessarily over the site of fracture, otherwise immobilisation will be defective It is applied during full expiration and is left *in situ* for three weeks (Fig 91)



FIG 91 —Strapping for fracture of one or more ribs should encircle the lower part of the thorax completely whatever rib is fractured.

FRACTURES OF THE SPINE

Fractures of the spine are important because of the prolonged disability which follows indifferent treatment, and because of the danger of injury to the spinal cord

FRACTURES OF THE VERTEBRAL BODY

Fractures of the vertebral body are usually due to violence causing acute flexion of the spine This is brought about by a fall from a height on to the heels or buttocks, or by heavy objects falling on to the back or head The force is transmitted to the anterior parts of the vertebral body thus crushing them together and causing a compression fracture or a fracture-dislocation of the body 60 per cent. of these injuries cause compression fractures and occur chiefly in the lumbar and dorsal region of the spine. Fracture dislocations are more common in the cervical and lumbar regions than elsewhere and the spinal cord is more prone to injury with this type of lesion the cord being nipped between the pedicle of the displaced vertebra and the body

of the vertebra below Compression fractures may cause cord paralysis by fragments from the comminuted vertebral body being pushed backwards into the vertebral canal The intervertebral discs are injured at the same time and in a similar manner to the vertebral body

Symptoms, signs, and treatment of vertebral fractures with no cord injury—The patient will give a history of an injury causing hyperflexion of the spinal column followed by pain referred to the injured area of the back Muscle spasm causes rigidity and limitation of movement of the back

The patient should be transported to hospital either in the position in which he is found lying or lying on his face with the spine extended The latter is preferable if no abdominal injuries are associated with the fracture *On no account must the patient be carried with the spine flexed* such as would obtain if he were lifted by the legs and shoulders

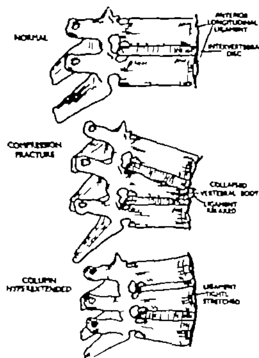


FIG 92.—The role of the anterior common ligament in reduction of vertebral fractures

After X ray examination the patient should be put to bed lying on his back, with two pillows placed at the site of injury to produce extension of the spine When the patient has recovered from surgical shock, the fracture is reduced and immobilised

The methods of reduction of compression fractures and fracture dislocations of the spine depend upon the anatomical fact that the anterior common ligament of the vertebrae is attached only to the intervertebral discs and the adjacent edges of the bone of the vertebral bodies Elsewhere it is separated from the anterior aspect of the bodies by loose

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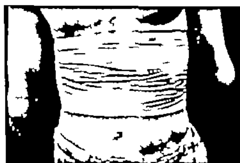


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placed in the dorsal position with two pillows under the concave area of the plaster, and the cast allowed to dry The patient s position should be frequently changed during the first twenty four hours so as to prevent pressure sores The following day he should be allowed up and exercises for the back and abdominal muscles commenced (Fig 94)



FIG 94 —Exercises such as depicted above are given to patients with vertebral fractures to develop the extension of the spine

The plaster jacket is worn for six months, when union and consolidation should be complete The patient is then put on a course of back mobilisation and resisted exercises There is no need to supply the patient with a back brace after removal of the plaster jacket. The provision of a brace will tend to create an impression in the patient s mind that not only is he not cured but that he is incurable

The Davis method of reduction (Fig 95) is very useful when the patient is unconscious or has other injuries which render the Watson Jones method unsuitable The patient is suspended by his ankles until the trunk is free from the table except at the sternum

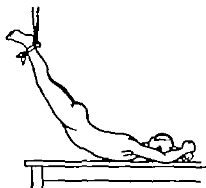


FIG 95 – Davis method of reduction of a fractured spine

The above methods are unsuitable for upper and mid dorsal vertebral fractures as they do not reduce the fracture sufficiently Reduction may be obtained by the Böhler method whereby the patient lies in the dorsal position and is suspended by a sling passed under the trunk at the site of the fracture (Fig 96) or by jacking up the patient on a motor-car jack A plaster jacket is applied as for lumbar

tissue Hence when the anterior parts of the bodies are crushed and compressed the ligament becomes buckled and loose. (Fig 92) If the ligament is stretched taut by hyper-extension of the spine, it will pull on the intervertebral discs and the adjacent cortical bone and will open out the compressed vertebrae

The methods of reduction in general use for lumbar and lower dorsal fractures are the Watson Jones and the Davis methods, and the Böhler method for dorsal fractures The patient is fitted with a stockinet vest, and the prominences of the vertebral spines and the iliac crests are padded with felt. With the Watson Jones method, the patient is placed between two tables, in the prone position in order that the weight of the body hyper-extends the spine (Fig 93) The posterior table is placed so that the trunk and pelvis are unsupported, and the patient rests with his arms on the anterior table so that the sternum is unsupported The anterior table should be 12 in higher than the posterior This position allows the trunk to sag completely between the tables and produces full hyper-extension of the spine This pulls on the anterior common ligament and reduces the fracture. If dislocation is present in addition, pressure is exerted over the prominent vertebra below the dislocation and reduction is effected

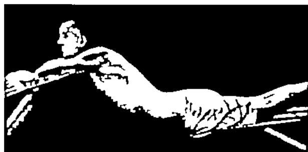


FIG. 93 —Patient placed in the Watson-Jones position for reduction of vertebral fractures. A plaster jacket is applied in this position.

A plaster jacket is then applied from the manubrium sterni to the symphysis pubis and groins anteriorly and from a corresponding level superiorly to the lower part of the sacrum and great trochanters of the femur on the posterior aspect of the body X rays are then taken to check the reduction and the patient returned to the ward Persistent backache will follow non reduction The patient should be

the cervical vertebrae are inclined much less than in other regions of the spine and thus predispose to dislocation Pure dislocation of the spine occurs in the cervical region only because of this anatomical fact and fracture-dislocations are more common than compression fractures

Reduction of fracture-dislocations and dislocations is best obtained by the use of continuous skeletal traction by means of skull calipers (Figs 98 and 99) This is to be preferred to traction with a leather halter which tends to cause pressure sores under the chin interferes with feeding and may cause recession of the chin



FIG 97 —Plaster immobilisation for an undisplaced fracture of the upper cervical vertebrae The plaster is usually trimmed to leave the ears uncovered

To apply the caliper the head must be completely shaved Small incisions down to the bone are made 1 in above the external auditory meatus The periosteum is erased and a quarter inch hole made with the special trephine The latter trephines only the outer table of the skull and cannot penetrate deeper because of a sleeve guard The caliper is then fitted into the trephine hole and mastisol dressings fixed round the skin incisions Weights are attached to the caliper and the back of the bed raised so that the body weight acts as counter extension The neck is slightly extended A small air ring is placed under the head to relieve pressure 20-30 lb weight traction is then applied to the caliper and X rays taken at 15 minute intervals until reduction is obtained Traction is then reduced to 10 lb After 13-14 days a plaster-cast is applied as for simple compression fractures which is worn for 3 4 months The cast is discarded if union is then firm

Manual manipulation and traction and immediate fixation in plaster under general anaesthesia is used by some surgeons but is not so safe as continuous skull traction

Cord injury associated with cervical injuries is very liable

fractures but the neck must be included when the fracture involves the upper dorsal vertebrae.

The above methods are contra indicated in certain types of fracture-dislocation where the inter articular processes are locked and prevent reduction by extension Treatment consists of excision of the superior articular facets of the vertebra below the one displaced thus allowing reposition of the dislocated vertebral body Immobilisation and after



FIG. 96.—Sling and hyper-extension method for reduction of fractures of the middle and upper dorsal vertebrae

treatment is then the same as for other fractures of the vertebral body

FRACTURES AND DISLOCATIONS OF THE CERVICAL SPINE

Uncomplicated crush fractures of the cervical spine are treated by immobilisation in a plaster including the head, neck, and shoulders with the neck hyper extended (Fig 97)

The articular surfaces of the inter articular processes of

to be fatal because of ascending oedema of the cord causing medullary paralysis

TREATMENT OF COMPRESSION FRACTURES AND FRACTURE DISLOCATIONS WHEN CORD PARALYSIS IS PRESENT

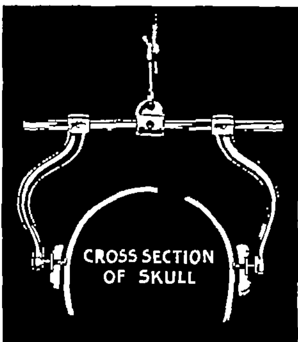
When the spinal cord is injured in association with vertebral fractures, there is a complete flaccid paralysis below the level of the cord lesion initially whatever the nature of the cord lesion This condition is known as spinal shock, and is characterised by flaccid paralysis of the muscles supplied by nerves issuing from the cord below the level of the level lesion loss of deep reflexes, anaesthesia below this level and paralysis of the bladder and rectum leading to incontinence from retention with overflow

If the cord has been contused these symptoms disappear after a few days If however the cord has been damaged so that the nerve tracts are also damaged, the condition of spinal shock may persist for 3–4 weeks Persistence of these symptoms beyond this time means a complete transverse lesion of the cord When the cord is partially transected some recovery occurs leaving the limbs spastic as in hemiplegia

Treatment should be directed to reduction of the bony displacement as soon as the patient's condition permits using the same technique as for fractures without paralysis

Immobilisation for dorsal and lumbar fractures may be obtained by enclosing the trunk and legs in plaster or by making a plaster bed and anterior shell Cervical spinal injuries are better treated by continuous skull traction (*vide supra*) Occasionally bone fragments are driven into the vertebral canal, especially if the laminae are fractured, and laminectomy is then necessary to remove the fragments, but this is the only indication for laminectomy in closed spinal injuries

If a plaster bed is not used, the patient may be nursed on a water or air bed which will prevent exertion of uneven pressure The patient must be frequently turned over in bed



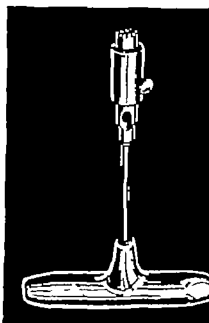


FIG 98 —Skull traction apparatus and special guarded trephine for use with apparatus.

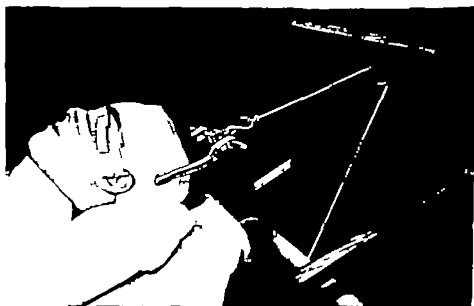


FIG 99 —Skull traction for injuries of the cervical spine A simple frame with pulley or Buck's extension hook, attached to the head-rest of the bed may be used to support the cord and weights. A padded ring is placed beneath the head to prevent pressure sores. This method allows ample pull and does not interfere with feeding or injuries to the jaws.

sulphonamide in saline, and some solution is run through to expel air before the tube connecting to an indwelling or supra pubic catheter is fitted to the apparatus The siphon loop is set at a height depending on the tone in the bladder, as shown by a cystometrogram Fluid *from* the drip *flask* is allowed to flow at the rate of 50–60 drops per minute with the siphon tube closed off so as to maintain the intra vesical pressure The level of the fluid in the manometer measures the intravesical pressure and should be read at fifteen minute intervals and charted As bladder con tractions occur a sharp rise in the manometer level will occur but as the bladder does not empty the musculature *accommodates itself by stretching and the pressure falls* This process is repeated with the level of the intravesical pressure gradually rising (Fig 101) From this an estimate of the bladder tone can be obtained *Having* reached a de cision as to the tone of the bladder the siphon loop is set at the requisite height, as indi cated by the surgeon and the siphon tube opened The drip fluid then runs into the bladder until the pressure in the bladder is sufficient to force the column of fluid over the siphon loop Drainage of the bladder by *siphonage* then follows and when empty the circle recommences

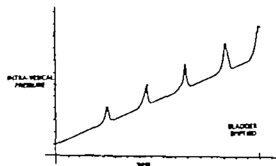


Fig 101 —Diagrammatic representation of cystometrogram.

If continuous tidal irrigation is not available, the bladder is drained by a supra pubic cystostomy and self retaining tube

Incontinence of faeces should be treated by the admini stration of a simple aperient each night, *e g* cascara or confection of senna to be followed by a simple enema the next morning The patient should be left on the bed pan for at least half an hour after evacuation as some leakage follows

Scrupulous attention must be paid to the skin and pressure

if pressure sores are to be prevented Pressure over the sacrum may be minimised by skeletal leg traction on a Braun frame by means of Steinmann pins inserted into the tibial tubercles 10 lb traction being applied to each leg

The care of the bladder is most important because of the urinary retention and the danger to life of the renal infection which may supervene unless care is taken The ideal method of treatment is that of continuous tidal irrigation of the bladder which serves to prevent urinary infection, relieve the retention, and preserve the small amount of bladder tone which may remain It has the advantage of avoiding frequent catheterisation with its attendant risk of infection and minimises the risk of a wet bed with its attendant bed sores and skin infection It must be borne in mind that urinary infection is the commonest cause of death if the patient survives longer than the first week after the injury

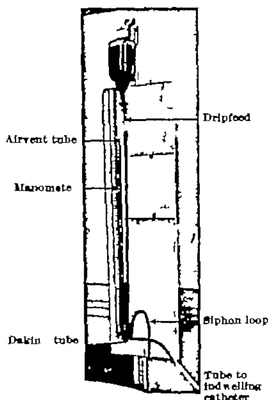


FIG 100 — Tidal drainage apparatus

The apparatus which the author uses is Stewart s modification of Bellis apparatus (Fig 100) It is attached to an indwelling catheter or supra pubic cystotomy catheter preferably the latter as infection is then minimal Before using the apparatus it must first be sterilised by running 1 in 60 lysol solution through the tubes The rubber connecting tubes are sterilised by boiling The apparatus is then thoroughly washed out with sterile water and fixed to the bed so that the Dakin tube is level with the symphysis pubis. The drip flask is filled with 0 5 per cent solution of

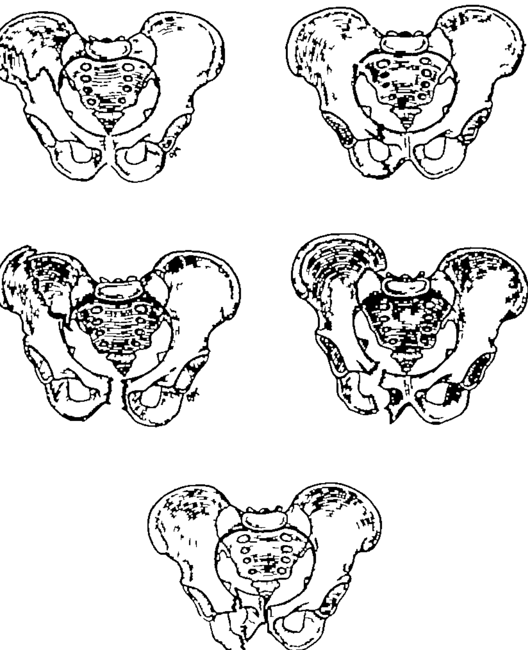


Fig 102

A and B Isolated injuries of the pelvic ring. There is no marked displacement and no special treatment is indicated

C and D Combined injuries of the pubic and iliac segments of the pelvic ring produced by antero-posterior compression There may be severe displacement. Patients should be nursed on their sides.

E Combined injuries of the pubic segment of the pelvic ring produced by lateral compression of the pelvis There is only slight displacement Patients should be nursed on their backs

points if bed sores are to be avoided and efforts must be made to keep the patient absolutely dry

The unfortunate sufferers of these injuries experience considerable mental depression as one would expect, and occupational therapy should be commenced as early as possible in an effort to alleviate this

If there is no evidence of recovery of the cord paralysis after eight weeks treatment, one can say that there will be little hope of any recovery occurring and traction and immobilisation can be discontinued. If recovery does occur re-education of walking will be necessary to overcome the element of spasticity which is invariably present.

FRACTURES OF THE TRANSVERSE PROCESSES

These are due to muscular violence, the processes being avulsed by strong contraction of the quadratus lumborum muscle of that side If one or two only are torn off recumbency in bed for 14–21 days followed by back exercises, will enable recovery to take place possibly within 6–10 weeks If more are broken and widely separated, indicating severe muscle damage a short plaster jacket is applied and worn for two months, the patient being allowed up immediately

FRACTURES OF THE PELVIS

Isolated fractures of the iliac crest and pubic rami are *due to direct violence*, and are *treated by recumbency for* six weeks. Leg exercises are continued throughout this period, after which weight bearing exercises are commenced

Fractures of both pubic rami or separation of the symphysis pubis together with fractures through the posterior part of the pelvis or dislocation of the sacro-iliac joint, are much more serious injuries, and are due to violence causing hyper-extension of the hip of the affected side The lateral fragment is usually displaced upwards and outwards, thus opening the pelvic ring There is considerable pain and bruising of the pelvic region made worse by pressure on the iliac crests or symphysis pubis (Fig 102) Good reduction

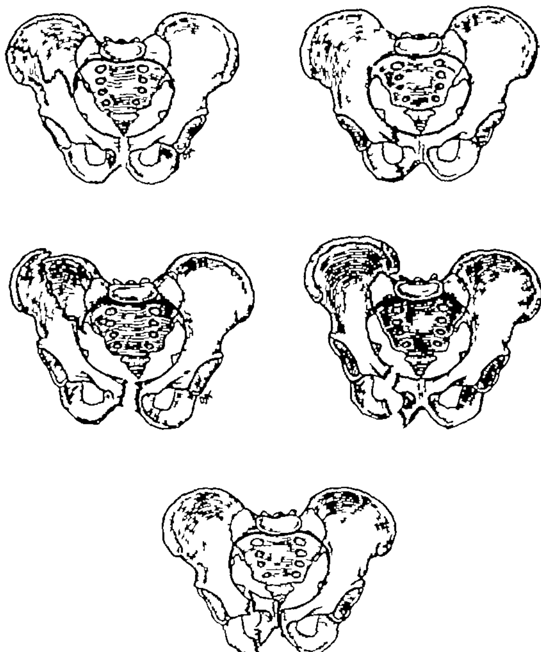


Fig. 102.

A and B. Isolated injuries of the pelvic ring. There is no marked displacement and no special treatment is indicated.

C and D. Combined injuries of the pubic and iliac segments of the pelvic ring produced by antero-posterior compression. There may be severe displacement. Patients should be nursed on their sides.

E. Combined injuries of the pubic segment of the pelvic ring produced by lateral compression of the pelvis. There is only slight displacement. Patients should be nursed on their backs.

must be obtained if walking is to be satisfactory later This may be obtained by manipulation under anaesthesia, with the patient lying in the lateral position on the unaffected

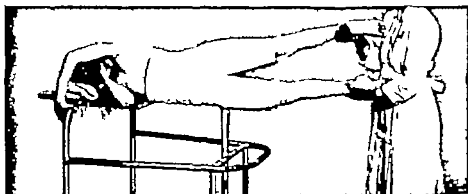


FIG 103.—Reduction and immobilisation of dislocation and fracture-dislocation of the pelvis by lateral recumbency The patient lies on the uninjured side. The dislocated ilium is rotated forwards and downwards and a double plaster spica is applied. (Watson-Jones method.)

side, and immobilisation in a double spica plaster (Fig 103) Another method is to apply traction to the fragment via the limb of the affected side by skeletal or skin traction, using 30 lb pull, and lateral compression and support by means of a pelvic sling (Fig 104) Of the two methods, the author prefers the pelvic sling and traction method as the lateral recumbency method is apt to produce pressure sores over the iliac crests. For nursing purposes, the patient raises his buttocks and the bed pan is slipped in between them and sling The immobilisation is maintained for 8–10 weeks, and if union is firm, full weight bearing exercises are allowed



FIG. 104.—A patient suffering from a fractured pelvis with displacement treated by pelvic sling and skin extension. The pulleys are normally fixed a little lower

Fractures of the pelvic ring may be complicated by

rupture of the urethra or bladder which need immediate operative repair The fracture must then be treated by the traction and sling method

FRACTURES OF THE LOWER LIMB

FRACTURES OF THE FEMUR

(*a*) **The femoral neck** —Sufferers of this injury are invariably over sixty years of age when senile rarefaction of the bone is occurring The fracture is due to indirect violence often apparently trivial such as slipping on a polished floor the patient usually falling to the ground after the receipt of the fracture. The patient complains of pain in the groin and hip although this may be very slight, and inability to walk On examination the leg is seen to be externally rotated due to the weight of the limb and shortened, due to the pull of the abductor and flexor muscles of the hip

Two main types of fracture of the neck of the femur are

(i) subcapital or transcervical
(ii) intertrochanteric types

Treatment depends largely on which type is present

The former is inside the capsule of the hip joint, *i.e* intra-capsular and union is difficult to attain unless internal fixation is used The intertrochanteric fracture is extra-capsular and union usually presents no difficulty

Transcervical fractures —The general condition of the patient largely determines whether reduction and fixation should be attempted, as many patients are too old to withstand this The latter should have the leg immobilised by placing sand bags on either side of the leg or by the application of a Liston long splint (Fig 105)



FIG 105 — Liston "long" or thigh splint.

If the patient is fit for operation and *can co-operate in the after treatment* treatment consists of reduction and internal fixation of the fracture It should be noted that these measures will not cure hypostatic pneumonia as is often stated but they are a large factor in the prevention of this complication, which commonly afflicted these patients before the Smith Petersen technique was available because the internal fixation allows the patient to be moved about freely in bed without producing pain The limb is immobilised by Russell



FIG 106 —X rays of fractured neck of femur before and after reduction and fixation with a Smith Petersen nail.

balanced traction for 6–7 days until the immediate risk of hypostatic pneumonia is past. (Fig 106)

For the operation, avertin or omnopon and scopolamine is given as a basal anaesthetic This can be supplemented by local anaesthesia or gas and oxygen The fracture is reduced on an orthopaedic table and check X rays taken (Fig 107) Through a lateral skin incision a Watson Jones guide pin is inserted so as to lie along the centre of the femoral neck. Its position is checked by X rays and repeatedly inserted until a correct position is obtained a guide being used to facilitate this A cannulated nail selected for its length, is then hammered over the guide pin so as to fix the

fragments of the fracture The guide wire is then withdrawn, the fracture impacted and the wound closed



FIG 107 —Instruments for the operation of insertion of a Smith Petersen nail and for treatment of fractures of the neck of the femur

( ) X-ray skin marker
(b) Watson-Jones guide-pins and introducer
(c) Hector-type of guide
(d) Stirling cannulated punch.
( ) Nail starter
(f) Smith-Petersen nails of various sizes
(g) Impactor
(h) Nail extractor

The patient is then taken back to bed and the limb immobilised by a cross bar fixed to the heel of a slipper and placed on a Braun frame (Fig 108) The cross bar prevents external rotation of the hip joint as it is this and abduction movements which are to be prevented until the fracture is united because of the strain they put on the fracture Further after treatment varies with individual surgeons, but my own practice is to commence quadriceps drill and ankle and toe exercises the day after operation supplemented if necessary by faradism to the quadriceps The patient is allowed up after removal of the skin sutures on the tenth day and is allowed to walk with crutches and patten bearing weight on the sound limb only Flexion and extension exercises for the hip and knee are begun immediately Weight bearing on

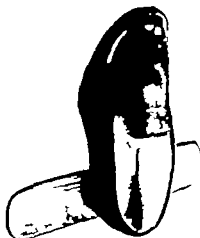


FIG 108 —Slipper with wooden cross-bar used after operation to prevent lateral rotation of the limb

the operated limb is not allowed until X ray examination reveals union to be present This normally takes three months and occurs in 80 per cent of cases

With patients who are unable to withstand the nailing operation a manipulative reduction is performed and a hip-spica plaster applied with the hip extended abducted and internally rotated This type of plaster is known as the Whitman spica named after Royal Whitman who first treated these fractures on a sound pathological basis The patient is allowed up on crutches the day after the application of the plaster Union occurs in approximately 30 per cent of cases treated by this method

Non union of fractures of the neck of the femur is treated by the performance of an oblique osteotomy of the shaft of the femur just above the lesser trochanter and by displacement of the shaft inwards for 1 in with abduction and slight flexion of the hip (Fig 109) This removes the shearing strain at the site of the original fracture, and allows union to occur A hip-spica plaster is applied, retained for twelve weeks, and then removed and weight bearing allowed The operation was devised by McMurray of Liverpool and is used by him for the treatment of recent fractures in addition to old fractures



FIG 109 —McMurray's osteotomy of femur Note the level of the osteotomy and the inward displacement of the lower fragment

Intertrochanteric fractures —Intertrochanteric fractures may be treated by the nailing operation, or by a Whitman spica plaster either method giving good results Another excellent method which is to be preferred to the plaster method is the Roger Anderson well leg traction splint (Fig 110) which allows the patient to sit up in bed and thus perform hip-flexion exercises Further the patient may be allowed up in a wheel chair (Fig 111) The action of the splint depends upon fixed traction the fixed point being the sole of the well leg A Steinmann pin is inserted into the

lower third of the tibia of the affected leg and then attached to the splint The pin together with the foot, is incorporated in plaster A plaster-cast is applied to the good leg after

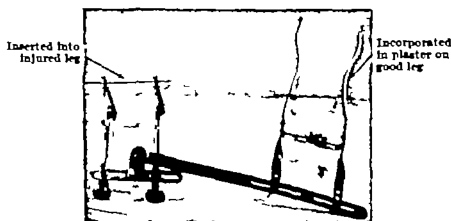


FIG 110 —Anderson well-leg traction splint.

applying felt to the sole of the foot, malleoli, and over the neck of the fibula. The ankle is dorsi flexed to 90° and the foot is held in slight eversion The cast incorporates the other



FIG. 111 —Well leg traction splint applied for intertrochanteric fracture The patient can be sat up in a wheel chair the day following application.

leg piece of the splint, and should extend from the toes to the mid thigh being higher on the medial side than the lateral in order to avoid pressure on the saphenous vein

It is well moulded over the bony prominences and the sole of the foot so that pressure is evenly distributed throughout the limb and may be cut out over the patella and malleoli.

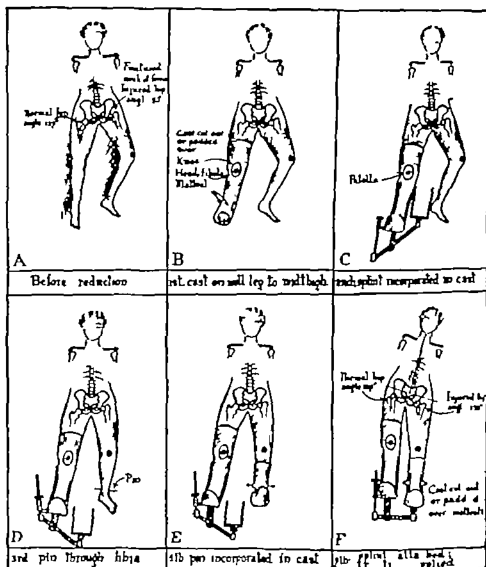


FIG 112 —Steps in standard routine application of well leg counter traction splint.

The two limbs are then fixed together on the metal cross bar of the splint, and the traction screws turned to apply traction on the affected leg This at the same time, applies pressure to the good leg These forces cause tilting of the pelvis

downwards on the affected side, thus causing abduction of the hip (Fig 112) The patient is propped up in bed thus flexing the hips, and movement in bed is encouraged The splint must be examined daily for any relaxation of the traction screws and any complaint of pain or pressure must be communicated to the surgeon immediately The splint is worn until union is firm this taking approximately twelve weeks After removal of the splint, active exercises are given for the hip and knee and walking exercises commenced

(*b*) **Fractures of the shaft of the femur**—*Birth fractures* of the femur may occur after difficult labours, especially when a leg is delivered in breech presentations The femur fractures below the lesser trochanter and the upper fragment is flexed 90 by the psoas muscle and abducted because of the loss of the pull of the adductor muscles which are inserted lower down the shaft of the femur Reduction must be performed or some permanent shortening will occur It is easily obtained by bringing the large controllable fragment into alignment with the small, displaced uncontrolled fragment To do this one suspends the baby from a gallows frame by means of skin traction tapes applied to both legs so that the buttocks lie free of the bed and the hips are flexed at least 90 (Fig 113) The baby can be lifted on the frame to the mother for feeding purposes After four weeks the fracture is firmly united and the baby may be removed from the frame



FIG 113—Birth fracture of the right femur treated on a small gallows bed The latter is resting on an ordinary bed.

Subtrochanteric fractures of the femur in adults have a similar displacement to the birth fractures and are best treated by the Roger Anderson well leg traction splint or on a Thomas splint as for a shaft of the femur but with the leg extremely flexed and abducted

Fractures of the shaft of the femur in children are treated on a gallows frame attached to the bed the child being slung from an overhead beam by skin traction tapes in order that the buttocks lie free of the bed The body weight acts as the extension force, but it can only do this if the buttocks are lifted off the bed The nurse must note each day that this condition is being fulfilled (Fig 114)



FIG 114 —Gallows-extension for fractures of the femur in children. Note that the buttocks are lifted off the bed The weight of the body and pelvis provides the extension force

There are numerous methods of treating *fractures of the shaft of the femur in adults* All depend upon the facts

(i) that the powerful thigh muscles cause shortening —traction must be used to counteract this

(ii) the upper fragment is flexed and abducted by the abductors of the thigh, which are not opposed by all the adductors, as the majority of these muscles are inserted into the lower fragment (Fig 115)

Thus to reduce we must bring the more easily controlled lower fragment into alignment with the upper fragment by abducting and flexing the hip and applying traction The normal anterior bowing of the femur must be restored if correct weight bearing in the limb is to be ensured

Some surgeons use continuous fixed skin traction on a Thomas splint Others use balanced skeletal traction on a Thomas splint with the knee flexed on a Pearson knee flexion bar or a combination of both methods

With the former method the fracture is reduced by manual traction and manipulation under general anaesthetic after application of the skin extension and Thomas splint and wooden back and side splints are applied to the femur to control the fragments. The traction tapes are tied to the end of the Thomas splint and the splint slung from a Balkan beam for twelve weeks (Fig 116(*a*))

With balanced traction a Steinmann pin is inserted into the tibial tubercle and weight traction applied to the Böhler

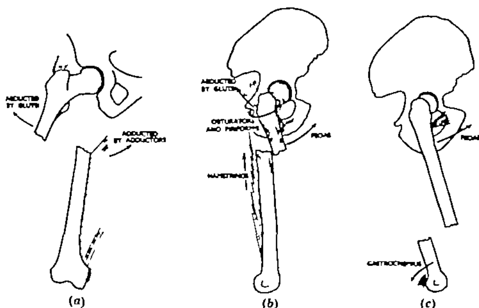


Fig 115

(*a*) and (*b*) Displacement of fragments of fractured upper or middle third of femur
(*c*) Displacement of fragments in fracture of lower third of femur

swivel stirrup fixed to the pin The swivel stirrup allows the stirrup to rotate on the pin and prevents pin movement thus minimising infection along the pin track. The limb is placed on the Thomas splint and knee flexion bar so that the knee is flexed 20 –30 In this position flexors and extensors of the knees are under the same tension The splint is slung from a Balkan beam and 20–30 lb traction applied Counter traction is provided by the weight of the patient and this is obtained by raising the foot of the bed 12–14 in The author combines this balanced traction with fixed traction by tying the Böhler stirrup to the end of the

Thomas splint. This causes the ring of the Thomas splint to fit firmly against the ischial tuberosity, and this fixation

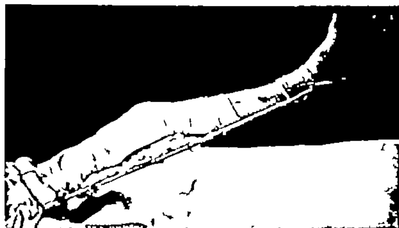


FIG 116 —Fractured femur treated by skin extension and fixed traction Note the padding to produce slight flexion of the knee and maintain the anterior bowing of the femur The gutter splints which are usually applied to the sides of the thigh have been omitted

cord must be tightened each day to maintain the fixed traction The latter effectively controls the upper fragment

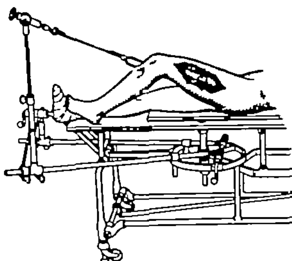


FIG 116A Strapping extensions applied for a fracture of the left femur following removal of the skeletal traction at the sixth week.

X ray control of the reduction is made and the weight reduced as soon as reduction is obtained this taking approxi

mately 10–24 hours Shortening can then be prevented by using 10–14 lb extension General body and breathing exercises are commenced immediately Toe and ankle exercises for the injured limb are begun at the same time while quadriceps drill and static contractions of the gluteus maximus may be commenced after 10–14 days

Nursing care is along the lines described under Thomas splint in Chapter II The weights should not be lifted or the Balkan beam moved for cleaning or bed making purposes



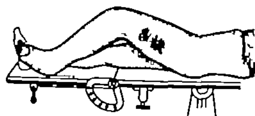


Fig 117A.—The plaster cast for compound fracture of the femur completed. Note the position of the limb (After Trueta.)

Fig 117 —Treatment of a compound fracture of the femur When an orthopaedic table is available it is an excellent practice to insert a Steinmann nail through the crest of the tibia The wound is then excised and the whole operation, including the application of the plaster cast completed. Note the flexion of the knee and the hip (After Trueta.)

The skeletal traction is changed to skin extension to the leg and to the leg below the knee at the end of six weeks, and the Steinmann pin removed (Fig 116A) This change is necessary to prevent strain on the ligaments of the knee which will follow prolonged skeletal traction 8 lb traction is applied to the extension above the knee and 6–7 lb traction to the one fixed below the knee Assisted active knee flexion movements are allowed at the end of ten weeks At the twelfth week radiographs are taken for the estimation of union If union is firm a walking caliper is fitted and the patient allowed to walk. The caliper provides non weight bearing movements without any weight being

borne by the injured femur It is removed daily for non weight bearing knee and hip exercises Pulley and resistance exercises for the muscles acting upon these joints may now be gradually introduced At the end of a further six weeks, the caliper is shortened so that the heel just touches the inside of the boot and so allows some measure of weight bearing The caliper is discarded completely after being worn for a period of three months

Some surgeons prefer to treat fractures of the femoral shaft on a Braun frame rather than on a Thomas splint. This method has the disadvantage that the upper fragment is uncontrolled and movement of the fragments occurs every time the patient is moved for nursing purposes

FRACTURES OF THE PATELLA

(*a*) **Transverse fractures of the patella** are due to indirect or muscular violence The two fragments separate, due to the pull of the quadriceps muscle, but can only occur when there is extensive tearing of the quadriceps expansion on either side of the bone The injury may be treated by operative fixation of the fragments and immobilisation in a plaster cast for six weeks or by excision of the patella and suture of the quadriceps tendon In both methods, by far the most important part of the operation consists in the firm suture of the quadriceps expansion on each side of the patella with No 3 chromic catgut Some surgeons use strips of fascia lata to aid suture of the quadriceps

The operation of excision is more popular to-day as it obviates the necessity for accurate alignment of the articular surfaces of the fragments and the necessity for prolonged immobilisation With excision three weeks immobilisation in plaster or by means of a pressure bandage, is sufficient, after which knee mobilisation exercises and re-education of walking are commenced Quadriceps drill and static contractions of the glutei are practised daily after operation to maintain the tone of these muscles, while weight and pulley exercises are begun at the fifth week

(*b*) **Stellate fractures** are due to direct violence, resulting in comminution of the fragments There is no separation of

the fragments, because the joint capsule is intact Treatment may consist of immobilisation in a walking plaster extending from the toes to the groin for six weeks As the patellar articular surface is severely damaged by the gross comminution osteoarthritis is a frequent sequel The majority of surgeons avoid this by performing an excision of the patella in preference to simple immobilisation in plaster After treatment resembles that described for the transverse fractures

FRACTURES OF THE TIBIA

Fractures of the tibia occur most commonly in the lower one-third of the bone, and may be spiral oblique or transverse in type Transverse fractures are due to direct violence and are often compound The fibula may be fractured at the same time, and this is found to be at approximately the same level as that of the tibia The subcutaneous position of the tibia aids reduction as one can visualise and feel that the alignment is accurate Manual manipulation is often all that is required to reduce the fracture which is then stable if a walking plaster-cast is applied from the toes to the mid thigh, with the ankle in neutral position between dorsi flexion and plantar flexion, and the knee flexed 10 The knee is flexed to prevent rotation of the upper fragment When the fracture is in the upper third of the tibia, the plaster should extend to the groin Static contractions of the anterior and posterior tibial muscles and gastrocnemius are commenced immediately and graded leg exercises and pulley and resistance exercises are added within the next few days Re-education by walking should be commenced as soon as possible to restore the normal heel and toe gait The cast is removed at the end of eight weeks and X ray examination and manipulation made to determine the presence of union If union is firm the patient is allowed to walk on the injured limb and full foot and leg exercises continued An Unna s paste or elastoplast bandage is applied from the toes to the knee to prevent oedema of the foot and ankle which often follows the removal of the plaster cast

Oblique and spiral fractures of the tibia are very often associated with a fracture of the fibula at the opposite end of the limb They are unstable fractures and are usually

complicated by displacement Reduction for lower one third fractures is obtained by skeletal traction on a Böhler screw traction frame using a Steinmann pin or Kirschner wire inserted through the os calcis followed by the application of a plaster-cast, over a metal strip from the toes to the mid thigh with the knee flexed 20°–30 (Fig 118) The Steinmann pin is incorporated in the plaster The plaster is split over the metal strip with a plaster knife as some swelling usually follows the strong traction (Fig 119) The leg is then placed on a Braun frame and a 7 lb weight tied to the traction stirrup (Fig 120) General body exercises and static contractions of the muscles of the injured leg ankle, and thigh are commenced immediately After 4–6 weeks when the danger of *immediate redisplacement* is passed the Steinmann pin is removed sterile gauze placed over the pin holes, and the plaster-cast changed a walking plaster then being applied as for a transverse fracture Weight bearing and resisted exercises are practised as for transverse fractures The cast is removed at the end of the tenth week, foot and ankle mobilisation exercises commenced and weight bearing allowed



FIG 118 —Screw traction apparatus for reduction of fractures of the middle and lower thirds of the tibia Traction is exerted with the knee flexed

Oblique and spiral fractures of the upper one-third of the tibia are reduced by traction on the extended leg on an orthopaedic table Immobilisation and after treatment is the same as for fractures of the lower one-third of the leg

It is essential in the treatment of all tibial fractures that the planes of the upper and lower articular surfaces should

be parallel or pes valgus or varus may result As this will be followed invariably by osteo arthritis of the ankle and subastragaloid joints the accurate alignment of tibial fractures is of considerable importance



Fig 119 —Splitting a leg plaster The metal strip is withdrawn when the cast has been split

There is at present a tendency to revert to operative fixation of tibial fractures by means of vitallium plates and screws but results do not seem to be an improvement over those produced by closed reduction

Fractures of the shaft of the fibula alone need a walking cast for six weeks Accurate reduction is unnecessary as the fibula is not necessary for weight bearing



Fig 120 Fractured tibia placed on a Braun frame after reduction 7 lb is applied

FRACTURE DISLOCATIONS OF THE ANKLE JOINT (POTT'S FRACTURE)

Fracture-dislocations of the ankle joint are loosely spoken of as Pott s fractures Strictly speaking a Pott s fracture is a fracture of the medial malleolus of the tibia with a fracture of the fibula 3 in above the ankle joint and dislocation of the ankle-joint This is only one of the many types of fracture-dislocations which occur at the ankle joint These injuries are satisfactorily classified into adduction

abduction and external rotation and vertical compression fractures

Adduction fractures are due to forcible inversion of the foot, such as falling off a kerb. Three degrees of severity are possible as indicated in the diagram (Fig 121) If the violence is moderate in severity (first degree) it results in an undisplaced fracture of the medial malleolus with or without tearing of the fibular collateral ligament. More severe trauma carries the astragalus and the foot medially and avulses the lateral malleolus in addition, the whole

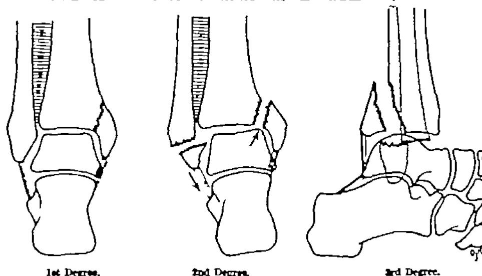


FIG. 121 —Three degrees of adduction fracture and fracture-dislocation of the ankle-joint (Pott Dupuytren type).

foot being displaced medially Where the violence is still more severe the posterior edge of the tibia is fractured and displaced backwards and medially with the foot.

Abduction and external rotation fractures are due to an abduction and external rotation strain at the ankle. Again three degrees of severity are recognisable (Fig 122) The moderate degrees of violence cause a fracture of the lower third of the fibula without displacement. More severe injuries result in displacement of the lower fragment laterally and avulsion of the medial malleolus or tearing of the medial collateral ligament of the ankle joint. The severest injury is where the posterior edge of the tibia (the posterior

malleolus') is separated and the foot and malleoli displaced backwards and laterally

Treatment —First degree adduction and abduction fractures need immobilisation in a walking plaster for four weeks followed by active weight bearing exercises as for fractures of the tibia The other injuries need manipulative reduction Accurate, anatomical reduction is essential in ankle-joint fractures, otherwise instability and osteo-arthritis of the ankle- and knee-joints will be the result because of abduction and adduction strains Manipulative reduction is carried

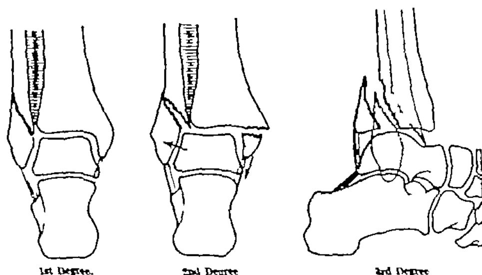


FIG 122 —Three degrees of abduction and external rotation fracture and fracture-dislocation of the ankle-joint.

out under general anaesthesia, sodium pentothal or gas and oxygen being very satisfactory for this The patient is placed on the theatre table with the legs hanging over one end so that the knees are flexed Knee flexion relaxes the gastrocnemius muscle which maintains any posterior dislocation The foot is pulled forwards and medially or laterally depending on the displacement, so that reduction is obtained The ankle is then held midway between full dorsiflexion and plantar flexion and a plaster-cast applied to the leg from the toes to the knee, carefully moulding the arches of the foot and the malleoli Firm pressure over the malleoli is maintained until the plaster is set so as to prevent displacement Eversion or inversion of the foot should not be

used for this purpose as mid tarsal stiffness may result. The patient is allowed up next day and allowed to walk on the sound limb with crutches and the sole and heel of the shoe raised and non weight bearing static, and resistance exercises commenced. After 2–3 weeks the cast may need changing as all swelling will have now disappeared. A walking shoe is then fixed to the plaster and the patient encouraged to walk on the injured limb. The plaster is removed at the tenth week, and if union is firm a compression bandage of the elastoplast type is applied and full weight bearing allowed. Foot mobilisation exercises complete the treatment for the majority of patients but with heavy subjects it is advisable to protect the union from any recurrence of the strain by crooking the heel (Fig 123) for six weeks.

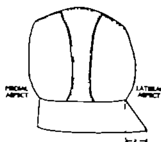


FIG 123 —" Crooked heel for adduction fracture

Vertical compression fractures (Fig 124) are treated by

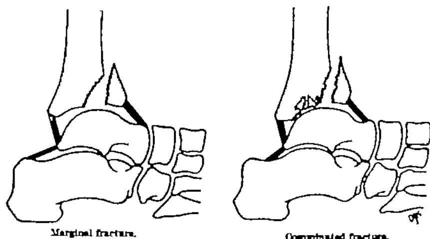


FIG 124 —Vertical compression fracture-dislocation of ankle-joint with anterior marginal fracture and forward displacement of astragalus.

manipulation or screw traction with the foot plantar flexed or by fixation with a screw. A plaster is then applied with the foot in this position. After six weeks, when callus is suffi

ciently firm to maintain the reduction the plaster is changed or a walking plaster applied with the foot dorsi flexed

Mal-united fractures of the ankle cause traumatic flat foot and osteo-arthritis of the ankle, because of the increased strain put on the joint In early cases, treatment consists of osteotomy of the tibia and fibula and correction of the alignment, but if osteo-arthritis is present, it is better to arthrodese the ankle joint

FRACTURES OF THE OS CALCIS

The os calcis forms the posterior pillar of the longitudinal arch of the foot, and any fracture which is associated with

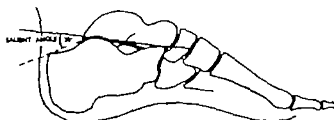


Fig 125 —Normal foot showing normal arch and salient angle

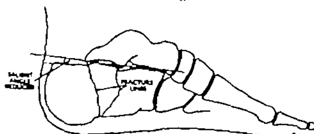


Fig 125a —Fractured os calcis with displacement producing flat foot and reduction of the salient angle

displacement of the fragments will affect the arch and the function of the foot Simple fractures with no displacement need immobilisation in a walking plaster for six weeks

When displacement occurs, the posterior process of the os calcis is usually displaced upwards thus causing flat foot associated with stretching of the ligaments and muscles of the sole of the foot (Fig 125) The tendo-Achilles is shortened thus reducing its power This displacement must

FIG 126 —Reduction of fracture of os calcis. Traction is applied from a transfixion pin in the os calcis in the long axis of the limb

FIG 127 — Second stage of reduction of fracture of os calcis. A transfixion pin has been introduced through the lower shaft of the tibia and traction is applied backwards, in the long axis of the tuberosity of the os calcis.

be corrected if the stability and the normal functions of the foot are to be restored. This correction may be obtained by skeletal traction on a Böhler screw traction frame with a Steinmann pin through the os calcis pulling first in the axis of the foot and then again in the normal axis of the tuberosity of the os calcis after a second Steinmann pin has been inserted behind the lower one third of the tibia to provide a fixed point for traction (Figs. 126 and 127.) Any broadening of the bone is corrected with the Böhler redresseur (Fig. 128.) A plaster is applied from the toes to the knee incorporating the os calcis pin only and continuous traction then applied to this on a Braun frame. Static contractions of the glutei quadriceps and muscles acting on the ankle and foot, and toe exercises are commenced the day after reduction. The traction is maintained for eight weeks and the pin then removed the plaster changed and a walking plaster applied. After twelve weeks this plaster is removed and foot

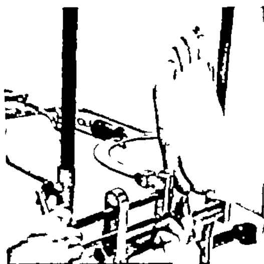


Fig. 128.—Lateral compression applied to the os calcis with Böhler's redresseur.

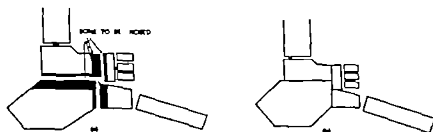


Fig. 129.—(a) Diagrammatic representation of triple arthrodesis of foot showing bone excised and joints fused.

mobilisation and weight bearing exercises commenced. Disability is often prolonged, but some improvement may occur at least six months after the injury.

For fractures which cause gross injury to the subastragaloid and mid tarsal joints and where some osteo-arthritis of these joints is inevitable, one may perform an arthrodesis of the mid tarsal and subastragaloid joints (triple arthrodesis) (Fig 129) within 4–5 days of the injury The same operation is used for disability after conservative treatment A plaster cast is applied after operation extending from the toes to the mid thigh and retained for a minimum period of three months After the removal of the plaster ankle and foot exercises are practised

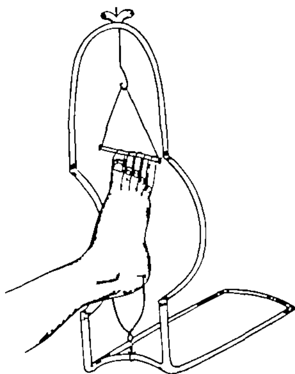


Fig 130 —Böhler arm frame being used for displaced fractures of the metatarsals and comminuted fractures of the scaphoid

FRACTURES OF THE METATARSALS

The metatarsals are frequently fractured as a result of heavy objects falling on to the dorsum of the foot. If no displacement is present, a walking plaster is applied from the toes to the knee carefully moulding the longitudinal and transverse arches The plaster is removed at the end of six weeks and foot exercises commenced Heavy patients are provided with arch supports until the postural muscles have fully regained their tone

If displacement is present reduction is obtained by screw traction applied by pulp traction on the toes. A fixed point for traction is made by inserting a Kirschner wire through the os calcis Traction is then applied by means of a Böhler arm screw traction frame (Fig 130)

A plaster-cast is then applied from the toes to the knee, with the foot in neutral position as regards eversion or inversion and dorsi flexion or plantar flexion A metal loop is incorporated in the plaster and the traction pins are tied to this to maintain continuous traction The patient is allowed to walk on the plaster The wires and plaster are removed after 7-8 weeks, and the after treatment carried out as for non-displaced fractures

DISLOCATIONS

Dislocations are rare as compared with fractures the latter being at least ten times more frequent. They are predisposed to by pathological conditions affecting the joint such as detachment of the joint capsule, or Charcot's disease Some joints are more prone to dislocation than others because of their anatomical structure This is well exemplified by the shoulder joint, which is a very unstable joint guarded by powerful muscles The hip joint however, has its bony articular surfaces so fitted together to produce stability, and powerful muscles and strong ligaments protect it from injury The exciting cause of a dislocation is often trauma, but pathological dislocation may occur from diseases destroying articular surfaces and ligaments This may occur in tuberculosis or acute infection of a joint. The dislocation may be congenital in origin due to defects in the development of the joint, the commonest examples being congenital dislocations of the hip and shoulder

In the commoner traumatic type the joint capsule and periarticular ligaments are torn and a haemorrhagic effusion into the joint results Compound dislocations are not common, but are serious injuries when present Vessels, nerves and muscles may be damaged as with fractures and complications such as pulmonary embolism delirium tremens, hypostatic pneumonia Volkmann's contracture and myositis ossificans may supervene The patient presents a deformed limb which is painful and is associated with swelling of the affected joint Loss of function is particularly marked because of interlocking of the bony fragments and muscle

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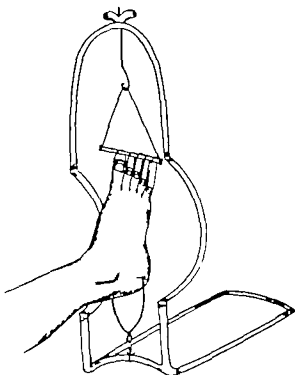


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by circumflex nerve paralysis causing deltoid paralysis, or by fracture of the greater tuberosity or rupture of the supraspinatus tendon

Reduction is obtained by the Kocher method of externally rotating and adducting the humerus and then rapidly internally rotating the humerus This method fails if the subscapularis muscle is torn, as the integrity of this muscle is essential for the manipulation Other methods consist of manual traction with the arm internally rotated and abducted and manual traction with counter pressure applied in the axilla (Hippocratic method) The arm is bandaged to the side for one week and active shoulder exercises then commenced If the greater tuberosity is fractured and separated the arm is immobilised for three weeks on an abduction frame

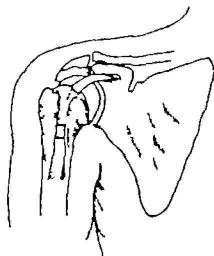


FIG 132.—Nicola operation for recurrent dislocation of the shoulder The biceps tendon is brought through a tunnel drilled in the head of the humerus.

Recurrent dislocation of the shoulder-joint may follow a dislocation of the shoulder following a blow from behind the joint It has been found that the cause of the repeated dislocations, often following trivial violence is an avulsion of the capsule and anterior part of the cartilaginous ring of the glenoid cavity Operative treatment is necessary for cure This may consist of repairing the defect of the glenoid cavity (Bankhart's operation) which is a difficult operation, or fashioning a new ligament with which to fix the humerus to the scapula The long head of biceps may be used (Nicola's operation) (Fig 132) or a ligament may be made from a free transplant of the peroneus brevis tendon (Henderson's operation) Many other operations have been devised for this condition but none give such good results as the above mentioned three After the operation the arm is strapped to the side with the elbow flexed and forearm supinated and maintained in this position for three weeks Finger

spasm. Treatment consists of immediate manipulative reduction skeletal traction and open reduction being rarely required

SOME COMMON DISLOCATIONS

(1) THE SHOULDER JOINT

When the arm is abducted no further movement than 90° is possible unless the arm is externally rotated If forcible

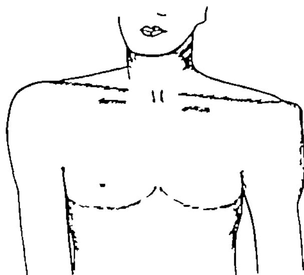


FIG. 131 —Dislocation of the left shoulder Note the flattening of the shoulder

abduction without lateral rotation occurs the greater tuberosity of the humerus is forced up against the acromion process. This levers the head of the humerus downwards out of the glenoid cavity and a sub glenoid dislocation results. Such a dislocation occurs as a result of a fall on the abducted arm

The initial displacement is sub-glenoid, but if the violence is severe, the head of the humerus may be forced to lie below the coracoid process (sub-coracoid dislocation) or below the spine of the scapula (sub spinous dislocation) These positions involve extensive laceration of the muscles around the joint. The shoulder is flattened and the acromion process very prominent. (Fig 131) The dislocation may be complicated

dislocation and in adduction flexion, and internal rotation with posterior dislocation The latter may be complicated by injury to the sciatic nerve

Reduction is obtained by manipulation The limbs must then be immobilised by continuous skin traction for six weeks to allow repair of the ligaments and capsule They carry most of the blood supply to the head of the femur and if they are not allowed to heal by permitting early movements of the hip avascular necrosis of the head will be liable to follow with the accompaniment of marked stiffness of the hip joint After six weeks weight bearing exercises are allowed

SPRAINS

Sprains may occur at any joint, but occur most commonly at the ankle and wrist X ray examination may reveal small fragments of bone detached where the ligament is inserted There is considerable pain and swelling and movement is often restricted because of this

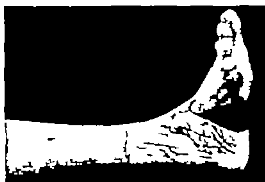


Fig 133.—Strapping applied for a sprain of the ankle

A sprain of the wrist is treated by strapping with elastoplast and commencing active movements immediately

A sprain of the ankle is treated by firm strapping and allowing early non weight bearing exercises (Fig 133) Injections of novocaine into the torn ligament ease the pain and allow active movements to be freely practised This is often followed by rapid resolution of the swelling The limb should be supported upon pillows between the periods of exercises If active exercises are not commenced early and oedema not controlled adhesions will form around the torn ligament and joint These cause a feeling of weakness in the joint associated with pain on the outer side of the ankle Treatment of the adhesions consists of a manipulation under anaesthesia to break them down and then the commence

and wrist movements are practised daily throughout this period When the fixation is removed, active elbow and shoulder exercises are commenced, but full abduction is not allowed until six weeks after operation when full remedial exercises are practised

(2) THE ELBOW

Dislocation of the elbow is usually posterior the lower end of the humerus being displaced forwards Manipulative reduction is followed by immobilisation in a sling for two weeks Finger and wrist movements are commenced immediately and active elbow movements commenced fourteen days later Volkmann's ischaemic contracture and myositis ossificans are very prone to follow a dislocation of the elbow unless immediate reduction is undertaken and care is taken in the after treatment to avoid passive movements

(3) THE CARPAL SEMILUNAR (LUNATE)

Dislocation of the carpal semilunar (lunate) may follow a fall on the dorsi flexed wrist The bone is dislocated forwards and presses upon the flexor tendons of the fingers and the median nerve as they lie in the carpal tunnel This causes flexion of the fingers and numbness and tingling in the thumb and lateral three fingers. **Reduction** is obtained by strong traction with the wrist gradually being moved from extension to flexion Failure necessitates open reduction but late cases are often better treated by excision of the bone

(4) THE HIP JOINT

Considerable violence is necessary to produce a dislocation of the hip but when it occurs, it follows violent abduction or adduction of the hip The dislocation of the head of the femur may be anterior or posterior *The leg is held in* abduction flexion and external rotation with the former

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CHAPTER VI

DISEASES OF BONE

ACUTE INFECTIVE OSTEOMYELITIS

ACUTE osteomyelitis is usually a disease of childhood and occurs most commonly between the ages of five and fifteen the condition being due, in 80–90 per cent. of cases, to infection by the staphylococcus aureus A minority of cases are due to infection by streptococci or pneumococci or on very rare occasions it is due to bacillus typhosus The child is often a devitalised subject because of chronic under nourishment and because of living in a poor environment

When questioning a patient suffering from acute osteomyelitis one can often elicit a history of a previous skin infection such as a boil or septic abrasion It is thought that these produce a low grade bacteraemia Previous recent injury to the affected bone is often noted and this trauma aids development of the bone infection by production of a haematoma This provides suitable soil for multiplication of the organisms

The disease is found to occur most commonly at the lower end of the femur the lower end of the tibia, the upper end of the humerus, and the lower end of the radius One naturally enquires why this is so These particular sites are rapidly growing areas, and it is found that the disease localises on the diaphyseal side of the epiphyseal line where the bone is very vascular and stagnation of blood is present. This region known as the metaphysis, is very liable to injury and strain which ruptures the blood vessels and produces a blood clot (Fig 185) Such a vascular area is consequently an ideal site for the development of a local acute inflammation

In acute osteomyelitis, the processes of acute inflammation are modified by the rigid, unyielding bone and the arrangements of the blood supply The outer layers of a long bone derive their blood supply from the periosteum and the inner layers from vessels in the medulla of the bone

ment of active exercises The shoe heel is 'crooked' to protect the ligament from any inversion strain, which would cause recurrence of oedema and the adhesions A condition of recurrent subluxation of the ankle may follow severe injuries to the lateral ligaments of the joint. It is treated by reconstruction of a new ligament from the peripheral part of the peroneus brevis tendon

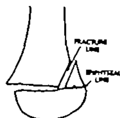


FIG 184.—Separation of an epiphysis. Note that the fracture line deviates from the epiphyseal line so that a fragment of diaphysis remains attached to the epiphysis.

EPIPHYSEAL SEPARATIONS

An epiphysis may separate from the diaphysis as a result of trauma, or as a result of pathological changes at the epiphysis such as occurs in syphilitic epiphysitis

Traumatic epiphyseal separations resemble fractures in their aetiology signs, symptoms and treatment. The line of separation usually deviates at one point so that a piece of bone is detached with the epiphysis (Fig 184) The importance of an epiphyseal separation is the danger of interference with growth at that epiphysis even after displacement is reduced

of the bone These form a new bony shell for the bone and this is known as the involucrum

If the metaphysis is inside the capsule of the adjacent joint an acute purulent arthritis may result from the spread of the infection to the exterior of the bone

Symptoms and signs

(a) *Pyrexia* is present and varies between 101°–103

(b) *Increased pulse rate*

(c) *Swelling* —To commence with there is no swelling present as the infection is contained in unyielding bone but oedema soon makes its appearance over the site of the infection and a fluctuating swelling is found when abscess formation has occurred

(d) *Toxaemia* is often a prominent feature especially when the onset has been rapid and considerable tension exists in the bone Pallor dehydration vomiting a dirty dry tongue and delirium are all evidence of its presence

(e) *Loss of function* —There is a psuedo paralysis of the limb because of pain and muscle spasm Movement of the adjacent joint is painful and restricted but this is not so marked as in acute arthritis

(f) *Tenderness* is very definitely localised to the meta physis and pressure there causes extreme pain

Complications

1 *Septicaemia* —This is heralded by further rise of temperature and pulse rate rigors and general deterioration of the patient A blood-culture is taken which may confirm the diagnosis Occasion ally septicaemia is the forerunner of an osteo myelitis the latter being a type of fixation abscess

2 *Pyaemia* —Pyaemic abscesses may develop in the lungs bones and joints following the detachment of fragments of infected thrombi from the vessels in the infected bone The joint affections are often surprisingly painless and pathological dislocation may be the first sign Hence the nurse should note any abnormal position of the limbs or mobility of

The intervening compact bone is nourished by vessels which *run in longitudinal* bony channels known as *Haversian canals*. The inflammatory process consists of vascular engorgement together with transudation of fluid and migration of cells from the blood into the tissues, i.e. into the inextensible bony canals. Thus the blood supply is *reduced by compression* of the vessels by the exudate. Further there is stasis in the vessels, and this together with the toxins produced by the infecting organisms, causes thrombosis. Necrosis of bone is the result. If the periosteum is rapidly stripped off the *bone by a subperiosteal* exudate the blood supply to the outer layers of bone is destroyed causing necrosis. Thus the net result of the action of the bacterial toxins and the circulatory disturbances is tissue death and the dead tissues together with leucocytes and organisms *form pus*. The pus bursts through the bone cortex and forms a sub-periosteal abscess.

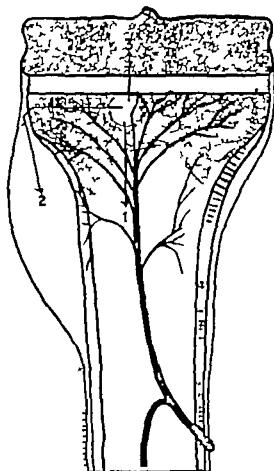


FIG 135.—Acute osteomyelitis.

The blood supply of a bone is shown in red, viz., the *nutrient artery* and the *many small periosteal vessels*. A small abscess forms (green) beneath the epiphyseal cartilage (blue). 1, 2, and 3 indicate possible methods of spread. 2 shows subperiosteal abscess which has destroyed the periosteal blood supply.

This may point and burst through the skin or spread up the shaft of the bone beneath the periosteum to re-enter the medulla and infect the marrow of the bone. The necrosed bone separates later to form a sequestrum. When the periosteum is raised off the bone by the inflammatory exudate, osteoblasts are carried with it from the outer layers

ment mentioned above, operative measures are necessary An incision is made over the metaphysis and the periosteum divided If pus is encountered many surgeons do no more than pack the wound lightly with vaseline gauze and immobilise the limb in plaster I prefer to drill the bone to relieve the intra-osseous tension before packing the wound and applying the plaster cast If no pus is encountered the bone is drilled and a vaseline gauze pack inserted after which the limb is immobilised as before Sulphathiazole powder is placed in the wound in order that the local action of the drug may be utilised

Despite the objectionable odour the plaster is not changed until it is crumbling or soaked with discharge The odour can be reduced by applying lactose solution to the wound, or by enclosing the plaster in a special deodorising cloth bag The cloth is impregnated with carbon which absorbs the gases causing the odour and its efficiency is not reduced if it becomes wet A bag will usually last 2–5 weeks before it becomes useless It should be burnt after use as it is highly infective

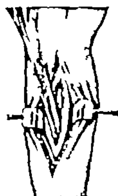


FIG 130 — Extracting a sequestrum with sequestrum forceps.

The plaster is changed when it is soaked with discharge and the wound cleaned with hydrogen peroxide It will be found that it is filled with clean healthy granulations Vaseline gauze and plaster is reapplied at suitable intervals until the wound is healed This method of vaseline gauze and plaster treatment is known as the Winnett Orr method It has the advantage that it abolishes the necessity for repeated painful dressings, and provides rest and drainage of the affected bone

Sinuses may continue to discharge for a considerable time this being due to the presence of a sequestrum a foreign body such as gauze or inadequate drainage Often small sequestra are discharged through the wound A larger sequestrum is removed when it is completely separated from the living bone (Fig 130) If no sequestra are present, the sinus is laid widely open and the wound made

the joints Rigors and continued pyrexia are suggestive of the onset of this complication

3 *Acute arthritis of the joint* may occur when the metaphysis is intracapsular A serous effusion complicates most cases of osteomyelitis but subsides when the bone condition is treated

4 *Spontaneous fracture of the bone* due to rarefaction following the increased vascularity of the bone which results from the infection.

5 *Secondary haemorrhage* from infection and necrosis of the wall of a large vessel.

6 In osteomyelitis of the skull infection may cause *thrombosis of an emissary vein* The infection may then spread to the large cerebral venous sinuses meninges and brain with fatal results

Treatment —*If the case is seen early* the limb is rested by immobilisation in a plaster-cast. General measures, such as the administration of liberal fluids and attention to the bowels are very important means of reducing the toxaemia. Sulphathiazole is given to combat the infection

The tablets should be crushed and given in ½–1 oz. of a mixture of sodium bicarbonate and sodium citrate containing gr xx of each fluid ounce Penicillin is now being used with encouraging results

The following table shows the suggested dosage

	Adults	Children		
		0–4 years.	4–10 years.	10–15 years.
Initial dose	6 tabs. (3 gms.)	1½–1 tab (¾–½ gm.)	2 tabs (1 gm.)	3–4 tabs. (1½–2 gms.)
Followed by (for 2 days)	3 tabs (1½ gms.) 4 hourly	1 tab (½ gm)	1½ tabs. (¾ gm.)	2 tabs (1 gm.)
Followed by (for 2 days)	Two-thirds approx. of above dose			
Followed by (for 2 days)	2 tabs. (1 gm.) 6 hourly	½ tab (¼ gm) 6 hourly	2 tabs. (½ gm) 6 hourly	1 tab (½ gm.) 6 hourly

If a sub periosteal abscess is present or where the pyrexia and rapid pulse rate persist despite the conservative treat

(2) **Acquired syphilis**—Syphilis may affect bone during the secondary stage forming a localised painful periostitis. The pain is characteristically worse at night probably due to increased engorgement of the periosteum due to warmth. In the tertiary stage gummata may occur in the shaft of long bones *e g* tibia in the skull and sternum. These may ulcerate through the skin giving the typical punched-out ulcer or the process may be diffuse and produce 'sabre-tibia' as in congenital syphilis.

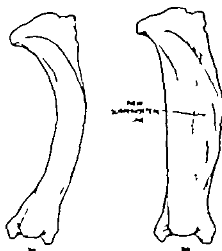


FIG 139

(a) Bowing of tibia due to rickets.
(b) Bowing of tibia due to syphilis. Note that this is due to deposition of new bone and not to bending of the bone as in rickets

Treatment is directed to the general infection by administration of antisyphilitic drugs such as neosalvarsan bismuth and potassium iodide

OSTEITIS DEFORMANS (PAGET S DISEASE)



FIG 140—Patient suffering from Paget s disease. Note the bowing of the femora.

Paget s disease is an affection of the skeleton which occurs in middle-aged subjects and is progressive in character leading to considerable deformity. No cause for the disease is known (Fig 140) It is associated with bending of the bones giving marked bow legs and kyphosis. This causes apparent shortening of stature. Thickening of the skull is often apparent to the naked eye and the patient becomes aware of this by reason of the fact that he needs increasing sizes of hats. Five per cent of sufferers from Paget s disease develop sarcoma of a bone. The other more common complication is that of patho-

into a saucer shaped cavity (Figs 187 and 188) This is then lightly packed with vaseline gauze and the limb immobilised in plaster The wound then heals by granulation tissue



Fig 187 — Saucerised " cavity following operation for chronic osteomyelitis.

When the wound is soundly healed and all vestige of infection has subsided physiotherapy may be commenced. This consists of active exercises and heat to increase the range of joint movement and re education in the use of the affected part

BRODIE S ABSCESS

A Brodie s abscess is a localised chronic bone abscess due to pyogenic infection It is treated by cutting a window through the bone which opens into the abscess cavity and then treating as for acute osteomyelitis

SYPHILITIC DISEASE OF BONE

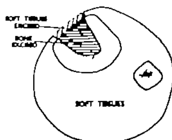


Fig 188 —Section through " saucerised " cavity showing area of soft tissue and bone removed.

(1) **Congenital syphilis** may cause a chronic periostitis Dense new bone is laid down under the periosteum, causing thickening of the bone This process is seen in the skull as thick bosses of bone, known as Parrot s nodes and in the tibia where the anterior surface of the tibia is thickened causing the well known sabre tibia The whole bone is not bowed as in rickets (Fig 139) Syphilitic necrosis of the nasal bones and nasal septum causes depression of the nose giving the typical saddle nose of congenital syphilis A similar necrosis of the skull bones causes thinning of the bone a condition known as craniotabes

immediately, calcium gluconate injections (20 c c t d s) or parathyroid hormone, or calcium lactate (gr 30 t d s) by mouth being administered A diet rich in calcium, e g containing considerable quantities of milk and cheese is necessary to restore the bones to normal After a few weeks the danger of tetany is past and the body becomes adapted to the lowered blood calcium When the bones are fully recalcified deformities may be corrected by manipulation or osteotomy

OSTEOGENESIS IMPERFECTA (FRAGILITAS OSSIUM)

Osteogenesis imperfecta is a generalised skeletal affection where the bones fracture easily and repeatedly as a result of the most trivial violence It is a hereditary disease and is due to a failure of normal differentiation of the bone forming cells, resulting in small thin decalcified bones Thus the growth is stunted The bones are extremely fragile, but the fractures, which are relatively painless unite very readily A curious anomaly associated with this disease is the presence of blue sclerotics due to an abnormal translucency of the sclerotic coat of the eye

Various degrees of severity are found The most severe form is seen where the infant is born with multiple fractures and cerebral injury due to the brain being improperly protected by the decalcified skull The infant is usually stillborn or survives only a few days From this form there are varying grades to the type where the child appears normal except for repeated spontaneous fractures There is no specific treatment for the general condition

RICKETS

Rickets is a general metabolic disturbance, resulting in bony defects, especially common in industrial areas where malnutrition and lack of sunlight are prevalent. It is due to a deficiency of Vitamin D often accentuated by a diet containing excess of cereals Our knowledge of the relation of Vitamin D and cereal diets to rickets is largely due to the researches of Gowland Hopkins McCallum and the Mellanbys

The bone lesion consists of irregular defective growth of the epiphyses resulting in their enlargement This enlarge-

logical fracture These fractures unite very quickly, but refracture is common No curative treatment is known

PARATHYROID OSTEODYSTROPHY

Parathyroid osteodystrophy is a generalised affection of the skeleton, due to the presence of a tumour or hypertrophy of the parathyroid glands Normally the parathyroid glands control calcium and phosphorus metabolism An excessive secretion of the parathyroid hormone causes an increase of the blood calcium and decrease of the blood phosphorus, together with decalcification of the skeleton This occurs in the presence of a parathyroid tumour Increased calcium excretion in the urine often occurs, resulting in the formation of renal calculi

The skeleton becomes softened and cystic, and pathological fractures occur The fractures are associated with *considerable pain and unite slowly often with deformity* Abdominal pain anorexia, and vomiting are common accompaniments and a considerable degree of anaemia is present Spontaneous pain in one or more bones is often present un associated with fracture It may be the only symptom and is often described as rheumatism. X ray examination of the painful region will reveal general decalcification of the bone and the presence of bone cysts These findings indicate *X ray examination of other bones as the condition affects* the whole skeleton

In untreated cases the pain becomes more generalised, while attacks of renal colic or haematuria may occur due to the passage of ureteric calculi An estimation of the blood calcium is made in all suspected cases and if raised, is diagnostic of over activity of the parathyroid glands The **treatment** consists of exploration of the neck for the para *thyroid tumour and removal of the tumour or hypertrophied* gland No local treatment of the bones is necessary apart from splinting the bones to prevent deformities, and the treatment of any fractures After operation a careful watch must be maintained by the nurse for early signs of tetany which may follow the rapid reduction of the blood calcium Twitching of the face or spasm of the hands are often the first evidence of this complication Treatment must be given

epiphysis. Examination of the blood reveals a normal calcium content, but the blood phosphorus is usually lowered. If the blood calcium is low, tetany and laryngismus stridulus may complicate the condition. The lowered body resistance often leads to complications, such as pneumonia, otitis media, and gastroenteritis.

TREATMENT

(*a*) **Prevention is of paramount importance.**—To-day active measures are taken by the administration of Vitamin D to pregnant women and to the infant, and by encouragement of breast feeding. Breast fed infants rarely develop rickets because they obtain Vitamin D from the breast milk. All infants under two years of age should be given one teaspoonful of 50 per cent. cod liver oil emulsion or three drops of halibut oil three times daily. A correct diet without excessive cereal and starchy foods, such as potato, bread, and biscuits, must be insisted upon.

(*b*) **Treatment of the general disease.**—When the disease is active, the child should be placed in the recumbent position and any weight bearing strictly forbidden in order to prevent the onset or exaggeration of deformity. If possible, the child should be nursed in the open air so that natural sunlight may be obtained. This may be supplemented by artificial sunlight, the ultra violet irradiation from both sources aiding the body to synthesise Vitamin D. Large doses of Vitamin D are given by mouth in the form of halibut oil or calciferol until the radiographs show the epiphyses to be clearly defined, thus indicating quiescence of the disease.

The diet should contain adequate amounts of calcium and phosphorus in balanced proportions. This can be obtained by giving large quantities of milk, eggs, and cheese. The limbs should be splinted to prevent deformity developing and to prevent the limbs being used. Massage and exercises are given to maintain muscle tone and so reduce the tendency to deformity.

(*c*) **Treatment of established deformities.**—*When the deformity is slight and the disease is still active*, as seen by X-ray examination, splinting and massage will often effect correction. With genu valgum (knock knee), the shortening of the

ment is conspicuous at the ends of the ulna and tibia, and over the costo-chondral junctions, the beaded appearance of the latter giving rise to the term rickety rosary The bones become decalcified and softened and bend easily This, together with the irregular growth of the epiphyses, produces the typical rickety deformities, e g anterior and lateral bowing of the tibia genu valgum and varum scoliosis and kyphosis (Figs 141 and 142) If the head is examined in young patients, it will be found that the anterior fontanelle remains open for an abnormal length of time, sometimes not closing before the third year Bosses of bone will be found on the frontal and parietal bones, and this together with the fontanelle defect, causes the so-called hot cross bun head



FIG 141 — Genu valgum and flat foot due to rickets.

The general effects of rickets are seen in the catarrh of mucous membranes causing bronchitis and diarrhoea Protrusion of the abdomen is due to flatulence and atony of the abdominal muscles and also to enlargement of the liver and spleen Excessive sweating and anaemia are common Walking is delayed in an infant affected by rickets, due to muscle weakness This is often known as the pseudo-paralysis of rickets Deformities develop first as a result of the weakness of the muscles and later become fixed, due to bony defects Dentition is delayed and defective predisposing to the early onset of dental caries X ray examination of the bones shows the deformities and a blurring and flaring of the metaphysis and



FIG 142 —Defects due to rickets. Note the protruding abdomen thickened wrist epiphysis and tibial bowing with associated flat foot and valgus of the ankles.

weeks for the lower limb and 6 weeks for the upper extremity

BONE NEOPLASMS

BENIGN BONE NEOPLASMS

(*a*) **Chondromata** —Chondromata are benign tumours arising from the cartilage of growing bone and may be single or multiple The solitary enchondroma usually occurs in the metacarpals and metatarsals expanding the bone to form cystic swellings They often undergo myxomatous degeneration and malignant change

Multiple enchondromata are usually seen in children and chiefly affect the bones of the hands They are thought to be due to growth disturbances and not true neoplasms

The enchondromata are treated by curettage of the cyst and swabbing with formalin to kill any remaining cells followed by the insertion of a bone graft if necessary and immobilisation in plaster until the bone has re-formed

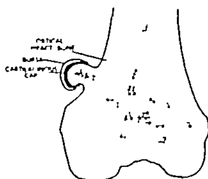


Fig 145 —Exostosis of the lower end of the femur

Solitary enchondromas project from the long bones the scapula and the pelvis They interfere with the function of the muscles and joints if of large size Sarcomatous degeneration is liable to occur They are treated by excision

(*b*) **Osteomata** —Small hard (*ivory*) *compact osteomata* are usually seen on the skull and in the external auditory meatus and are of no orthopaedic significance

Cancellous osteomata are usually seen in adolescents as projections which grow from the epiphyseal cartilage They are elongated and point away from the epiphyseal cartilage, usually having a bursa situated over the free end (Fig 145) They cause *symptoms* largely by interference with the free play of tendons Treatment consists of excision of the exostosis and the bursa

Multiple exostoses (Diaphyseal Aclasis) is a familial defect

external collateral ligament, biceps and iliotibial band must be treated by passive stretching aided by massage designed to improve the general circulation and muscle tone The vastus internus gracilis sartorius, and semitendinosus which are stretched by the deformity need strengthening by exercises Attention should be paid to the coincident flat foot and valgus of the ankles by wedging the inner sides of shoe heels $\frac{3}{16}$ in and by foot exercises In genu varum (bow legs) the contracted tissues are on the inner aspect of the leg and treatment is given along the lines for genu valgum stretching the contracted tissues and giving exercises for the stretched muscles on the outer aspect of the knee *If the disease is not active* walking braces are often sufficient to effect correction. (Fig 143) Manipulation under anaesthesia may correct these slight deformities.

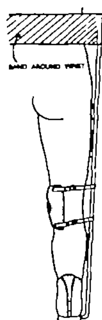


FIG 143 — Walking corrective brace for genu valgum.

For extensive deformities in young subjects of 2–4 years of age, osteoclasis is used It may be performed by manual fracture of the bones over an orthopaedic wedge (Fig 144) or by means of a Thomas osteoclast. The limb is then immobilised in plaster for 10–12 weeks in the case of the lower limb and for a shorter period in the upper limb



FIG 144 Manual osteoclasis of the tibia over an orthopaedic wedge

Open osteotomy is used for correction of *established deformities in older patients* and when the deformity is near a joint, when osteoclasis may damage the epiphyses. After osteotomy the limb is immobilised in plaster in the corrected position until union is firm *i e* a minimum of 12

being the more malignant type At first the periosteum is intact and is lifted off the cortex by the enlarging tumour New bone is laid down under the periosteum at right angles to the cortex of the bone forming a series of radiating spicules These typically have a "sun ray" appearance and lie along the blood vessels passing from the periosteum to the cortex

Later the periosteum is perforated and the soft tissues are invaded The skin becomes stretched over the rapidly growing tumour but ulceration is rare

In addition to the local spread of the tumour secondary deposits are formed in the lungs at an early date as a result of dissemination of emboli of tumour cells by the blood stream

Osteogenic sarcoma usually occurs during the second decade but may appear as a complication of Paget's disease in elderly subjects

The first symptom is pain near a joint, soon followed by the appearance of a swelling The swelling is not tender but feels hard and irregular with the occasional presence of cystic areas There is often a history of slight injury which may precede the onset of the tumour by two or three months Pathological fracture may occur in the more cellular type of tumour The presence of a cough usually indicates the existence of metastases in the lungs An X ray examination of the tumour and the chest is taken in all cases to confirm the diagnosis and detect the presence of metastases



FIG 146 —Sarcoma of the femur Note the dilated subcutaneous veins.

Treatment.—Local resection is never performed as diseased tissue is liable to be overlooked rendering the opera

in the growth and remodelling of the diaphyses and epiphyses. The exostoses are removed when they interfere with function

(c) **Giant cell tumours** —Giant cell tumours occur in the epiphyses of long bones and cause large cystic tumours, the end of the bone being greatly expanded so that the cortical bone is a mere shell Palpation then may reveal crepitus, which resembles the crackling of an egg shell The tumour consists of fibrous tissue and clusters of giant osteoclasts, with bony trabeculae crossing the cyst

The symptoms complained of are pain and swelling at the end of a long bone, the patient usually being a young adult Occasionally a pathological fracture occurs X ray appearances are usually diagnostic but biopsy may be necessary to confirm this evidence

Treatment of a giant cell tumour may be by deep X ray therapy curettage of the cyst and bone grafting excision of the cyst, or amputation Simple curettage is liable to be followed by local recurrence. Local treatment should be combined with deep X ray therapy These neoplasms occasionally metastasise

PRIMARY MALIGNANT BONE TUMOURS

The commonest primary malignant tumours of bone are contained in the three classes

(1) Osteogenic sarcoma
(2) Ewing's tumour
(3) Multiple myeloma

(1) Osteogenic Sarcoma.

Osteogenic sarcomas are important tumours because of their frequent occurrence and tendency to rapid local destruction and early spread to the lungs They originate in cells whose normal function is the production of bone. The majority arise beneath the periosteum at the metaphysis of a long bone growing into the medullary cavity and beneath the periosteum They have a predilection for the lower end of the femur and upper ends of the tibia and humerus where growth is most active The tumour destroys part of the shaft of the bone It forms atypical bone cartilage or osteoid tissue in varying proportions, the more cellular and vascular tumours

This organism must reach the human body by the ingestion of infected milk

A previous history of one of the infectious fevers an injury or malnutrition predispose to the bone infection by reducing the general and local resistance to infection The organism reaches the bone by spread via the blood stream from infected lymph glands The disease commences at the metaphyses, and affects the vertebrae skull femur short bones of the hands, and the humerus in that order of frequency

The lesion consists of clusters of tubercles which cause decalcification and erosion of the bone Expansion of the bone and caseation usually occurs with the formation of tuberculous pus This may spread through the bone to form abscesses in the soft tissues The pus tracks between the muscles and eventually points at a skin surface and if un treated it ruptures and forms an indolent sinus Secondary infection of the sinus and the bone then follows Thus one should never drain a tuberculous abscess as this is invariably followed by secondary infection and the production of a chronic sinus Under effective treatment the lesion becomes walled off by fibrous tissue and becomes fibrosed and may later calcify

SYMPTOMS AND SIGNS

Pain which is a dull continuous ache is the chief com plaint, but occasionally the appearance of an abscess may have called attention to the condition There is swelling over the affected region but redness of the skin is absent, and tenderness is not a marked feature The muscles of the affected limb become wasted and, by virtue of painful spasms hold the neighbouring joints in a deformed attitude

The general signs of tuberculosis viz night sweating pyrexia and an increase of the pulse rate toxaemia and general wasting are usually present

A Mantoux tuberculin test may be performed to aid diagnosis in children but only a negative result is of value, as a high proportion of subjects have had lymphatic gland infection which gives a positive result whether bone tuber culosis is or is not present. An X ray examination is necessary before the diagnosis can be made with certainty

tion incomplete. Radical excision is obtained by amputation. *Some surgeons treat the tumour with deep X rays but this often fails as areas of tumour are not always completely destroyed and recurrence is then inevitable.* Even if the tumour is destroyed pathological fracture may occur. The best results are given by the deep X ray therapy and subsequent amputation, but the ultimate results of any form of treatment at present are poor. Injections of Coley's fluid, which consists of a sterilised broth culture of streptococci and bacillus prodigiosus, are rarely employed to-day.

2. **Ewing's Tumour.**—Ewing's tumour is a very malignant neoplasm arising from the shafts of long bones before the age of twenty. It grows very rapidly and is highly vascular. It causes pain and is usually accompanied by pyrexia. This *may cause an erroneous diagnosis of acute osteomyelitis to* be made. The tumour is highly radiosensitive and treatment consists of deep X ray therapy. These measures cause rapid disappearance, but a local recurrence and metastases in the lungs always appear and recovery is almost unknown.

3. **Multiple Myeloma.**—Multiple myelomas are multiple malignant tumours of bone which occur in middle aged subjects. They arise from the cells of bone marrow and occur in the ribs, sternum and skull, pelvis and femur, many bones being simultaneously affected. The lesions are extremely painful, and are associated with anaemia and marked cachexia. Examination of the urine reveals the presence of Bence-Jones protein, a protein which precipitates during heating and redissolves on further heating to the boiling point. X ray examination shows "punched-out" areas in the affected bones.

Radiotherapy is usually given in a vain hope that some permanent response may be obtained, but the prognosis is hopeless.

TUBERCULOSIS OF BONE

Tuberculosis of bone is a common and serious infection which affects children more commonly than adults. The infection is due to either the bovine or human type of tubercle bacillus. Various authorities give different figures for the frequency of each type of infection, but there is agreement that at least 30-40 per cent. are due to the bovine type

This organism must reach the human body by the ingestion of infected milk

A previous history of one of the infectious fevers an injury or malnutrition predispose to the bone infection by reducing the general and local resistance to infection The organism reaches the bone by spread via the blood stream from infected lymph glands The disease commences at the metaphyses, and affects the vertebrae skull femur short bones of the hands and the humerus in that order of frequency

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The general signs of tuberculosis viz. night sweating pyrexia and an increase of the pulse rate toxaemia and general wasting are usually present

A Mantoux tuberculin test may be performed to aid diagnosis in children but only a negative result is of value as a high proportion of subjects have had lymphatic gland infection which gives a positive result whether bone tuberculosis is or is not present. An X ray examination is necessary before the diagnosis can be made with certainty

A biopsy of one of the lymphatic glands draining the affected region will often point to the correct diagnosis

TREATMENT

General treatment.—It must be always borne in mind that the patient is a tuberculous individual and must be treated as such Hence general measures are extremely important and of these complete general and local rest, combined with sanatorium measures, are the most valuable. The diet should have a high calorie value with lavish proportions of dairy produce and vitamins

Heliotherapy is valuable in promoting improvement of the general condition and the following course, along lines suggested by Sir Henry Gauvain will be found useful when it is employed It is essential that the head be covered with a canopy or sun hat, and any excessive erythema or blistering must be avoided Only patients who have no evening rise of temperature above 100 F before and during the course should be allowed to proceed with it. A record of the exposure should be kept

First day—Expose the legs to the knees for 5 minutes hourly for 8 hours
Second day—Expose the legs to the knees for 10 minutes hourly for 3 hours
Third day—Expose the legs to the groin for 10 minutes hourly for 8 hours Then turn over and repeat as for the first day
Fourth day—Expose the groin and buttocks for 10 minutes hourly for 3 hours and both aspects of the legs below
Fifth day—Expose as for third day plus area of trunk for 5 minutes hourly for 3 hours
Sixth day—As for fifth day plus 5 minutes to another area of trunk
Seventh day—Expose as for sixth day but double the trunk exposure
Eighth day—Expose for 20 minutes.

The exposure is gradually increased until the total exposure of 3 hours per day is reached

Local treatment—Local measures should be conservative

except when the disease can be completely removed without interfering with function The latter is rarely possible except in the infection of the ribs The aims of treatment are to provide rest and to prevent deformity and secondary infection until natural healing occurs The affected part is thoroughly immobilised by a plaster-cast or by means of special splints Abscesses should be repeatedly aspirated under sterile conditions If the skin becomes necrotic the necrosed area should be excised the abscess cavity scraped and swabbed with B I P P (bismuth, iodoform paraffin paste) and then closed, using skin sutures only

Operative measures are indicated when

(1) the disease is progressing despite conservative treatment

(2) there is secondary infection present

(3) sequestra are present

Operations consist of excision or curettage followed by immobilisation When numerous infected sinuses are present amputation may be necessary

TUBERCULOSIS OF SPECIAL BONES

Tuberculosis of the Spine (Spinal Caries)

Tuberculosis of the vertebral column and Pott s disease have been synonymous since 1779 when Percival Pott first described the lesion It occurs chiefly in childhood and is commonest between the ages of three and six

The infection reaches the vertebrae by spreading from a tuberculous focus elsewhere usually from a tuberculous adenitis The lower thoracic region is affected more often than other parts of the spine and this is thought to be largely due to the constant movement and strain which occurs in the thoracic region because of respiration The disease begins at the metaphyses of the upper and lower surfaces of the body although in adults, it more often begins on the anterior aspect of the body beneath the anterior common ligament The bone is destroyed and the weight of the body causes it to collapse and become compressed As the neural arches are still intact the vertebrae above and below the destroyed

bone pivot on the intervertebral joints and the collapse becomes more marked anteriorly (Fig 147) This causes the spinous processes of the affected vertebrae to be prominent the projection being known as a gibbus The deformity is most marked in the thoracic region because the anterior parts of the vertebrae bear most of the weight In the cervical and lumbar regions however the inter articular processes support the bodies above, and thus little deformity is found when these regions are affected Granulation tissue from the diseased vertebrae may spread backwards into the spinal canal and press on the spinal cord giving paraplegia The deformity alone is rarely a cause of paraplegia

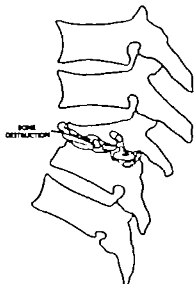
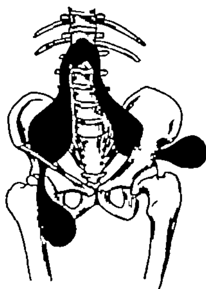


FIG 147 —Bone destruction and collapse of the vertebrae resulting from tuberculosis.

SYMPTOMS AND SIGNS

1 *Pain* —The pain is felt over the affected region of the back and radiates in a girdle-like manner round to the sides and anterior part of the body It may simulate pleurisy or recurrent appendicitis, and is often diagnosed first as rheumatism or neuritis Palpation over the affected spinous processes causes severe pain

2 *Abscess formation* —The abscesses are due to the tracking of pus and granulation tissue along muscle planes and the sheaths of vessels. In affections of the lower thoracic and lumbar region the psoas abscess occurs It tracks downwards


FIG 148 —Potential abscess track spinal in caries.

under the psoas sheath and points in the right iliac fossa above Poupart's ligament lateral to the iliac vessels or in the groin medial to the femoral vessels. Secondary tracks along vessels may cause it to point at the knee or in the back of the thigh (Fig 138). When the disease affects the upper thoracic vertebrae abscesses track along the intercostal nerves and may point over the ribs or in the mediastinum. Cervical caries produces abscesses which may point in the retropharyngeal region causing dysphagia and dyspnoea or they may point in the neck behind the sterno-mastoid muscle.

3 *Deformity* due to bone destruction. This may cause antero posterior or lateral angulation (Fig 140).

4 *Muscle spasm*.—Muscle spasm giving rigidity deformity and limitation of movement of the spine is an early sign. In cervical disease torticollis may result or the head may be held in an exaggerated military attitude. The head is usually supported by the hands to prevent any painful movement.



FIG 140.—Tuberculosis of the spine showing the deformity of the spine

5 *Paraplegia*.—The earliest sign is spasticity of the legs but if the condition progresses, the deep reflexes may disappear and flaccid paralysis and sphincter involvement ensue causing incontinence of urine and faeces.

TREATMENT

General treatment is the same as for tuberculosis of bone in other regions but it is stressed again that the importance of this part of the treatment equals that of the local treatment.

Local treatment.—All cases should be treated by rest immobilisation and recumbency until the disease is quiescent. The disease may be said to be quiescent when repeated X ray examination reveals no further decalcification and shows definite clearly defined vertebrae and when the pulse rate blood sedimentation rate and temperature have remained normal over a period of 2–3 months. This usually takes two years. During immobilisation the spine is fixed in hyper extension as this position reduces the tendency for paraplegia to

supervene Various methods of immobilisation are available

(a) *Bradford frame or Whitman frame*—The frame is angled at the site of the disease to produce hyper extension (As Figs 28 and 29)

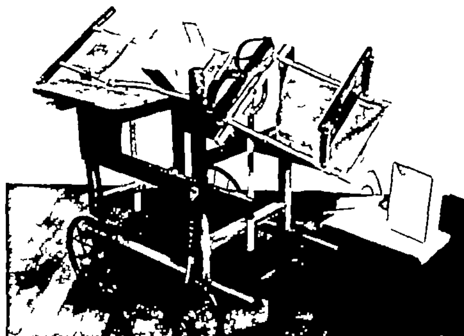


FIG 150—Pugh extension frame for spinal tuberculosis.

(b) *Pugh spinal extension frame* (Fig 150)—The patient can be turned from side to side on the frame thus facilitating renal drainage (*vide infra*)

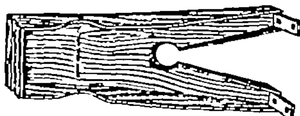


FIG 151—Phelp box. The box is fitted with a mattress. The legs are bandaged to the box with flannel bandages. A wide sheet is used to secure the body in the box by passing it over the trunk and under the box By this means the whole of the body from the axilla downwards is immobilised The disadvantage of the box is the necessity for removal of the child from the box for attention to the back and for cleaning the tray thu mo ing the spine

(c) *Phelp's box* (Fig 151)—The box is rather longer than the child and is fitted with a mattress The child is bandaged in the box with flannel bandages It has the disadvantage that the child must be lifted out of the box at least once per week for the purpose of cleaning the box

(d) *Thomas double hip splint with head band*—This is a useful means of immobilising young children



FIG 152.—Fixation of the patient in a posterior plaster shell by bandages. The shell is mounted on a wooden frame Note the hyper-extension of the spine



FIG 153.—Tuberculosis of the spine When the child has been turned in the complete anterior and posterior shells, the posterior shell can be removed for treatment of the back. Note that the posterior shell has been cut away over the buttocks for nursing purposes.

(e) *Plaster beds* (Figs 152 and 153)—Plaster beds are superior to the above because excellent immobilisation is obtained and the bed fits the patient perfectly thus ensuring comfort. Anterior and posterior shells are made and the patient is bandaged into one It is important to strap both shells over the patient before



Fig 154 — Head suspension for the application of a plaster jacket. The patient is suspended so that his toes can just touch the floor

turning for nursing purposes and daily attention to the back If the patient is lying in a posterior shell, he should lie in the anterior counterpart for 2–3 hours twice a week to prevent the formation of urinary calculi These are prone to form when patients are recumbent for a considerable period.

When the cervical region is affected, severe muscle spasm is a common accompaniment and some form of traction is necessary e g by means of a head halter and 2–3 lb traction applied for 6–9 months Immobilisation may then be continued in a plaster-cast which includes the head, neck, and shoulder region

When the disease is quiescent ambulatory treatment may be commenced, the patient being allowed up in some form of support, such as a plaster jacket or spinal brace (Figs 154 and 155) This support is worn for 12–18 months until the diseased area has become firmly consolidated The brace may then be removed for a few hours each day gradually increasing the period until the patient can leave it off completely If there is any pain or increase of any deformity the support must be reapplied Finally the patient should be examined once every three months for a period of two years before ultimate discharge



Fig 155 Celluloid collar used in the convalescent stage of cervical spinal caries

In adults there is often some residual backache when the disease is healed because of the altered mechanics of the intervertebral joints as a result of deformity. To counteract this and also as a means of providing a permanent spinal support a spine fusion operation may be performed. A spinal jacket is applied before operation and bivalved, the operation being conducted with the patient lying prone in the anterior half of the jacket. A bone graft is cut from the tibia with the Albee saw, the leg being fully flexed whilst the graft is being cut. The graft is placed between the split spinous processes of the vertebra (Fig. 156.) After operation the posterior half of the jacket is replaced and the two halves

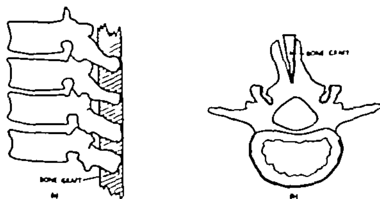


Fig. 156 (a) and (b) Albee spine-fusion operation. The bone graft is cut from the tibia and inserted between the split spinous processes.

fixed together. The plaster jacket is worn for 4-6 months at least but it is not removed until the bone fusion is firm.

Treatment of complications.—(1) *Abscesses* are treated by repeated aspiration. Any sinus should be kept dry and covered with dry sterile gauze. In the presence of secondary infection and persistent pyrexia the sinus may be enlarged to allow adequate drainage or preferably excised. When large mediastinal abscesses complicate thoracic disease the abscess may be evacuated by the operation of costo-transversectomy, when the transverse process of the affected vertebra and 2–3 in. of the adjacent rib are excised. The abscess is then evacuated and the wound closed without drainage.

(2) *Paraplegia.*—Treatment is similar to that for paraplegia associated with fractures and cord injuries. Contrac

tures of the extremities are prevented by careful splinting The spine is immobilised in hyper extension and abscesses sought for and evacuated Laminectomy is very rarely indicated for the relief of paraplegia

If paralysis persists after healing of the bone lesions, the patient may be enabled to walk by means of tripod walking This method of walking can be utilised if knee flexion is avoided by the provision of a walking caliper for each leg and gluteal paralysis compensated by the method of using the crutches The crutches are placed well apart and forwards so that they form the two limbs of a tripod the legs forming the posterior and third limb

Tuberculosis of Metacarpals, Metatarsals, and Phalanges

Tuberculosis of the bones of the hands and feet is rare after the age of five The affected digit appears swollen and shortened and sinuses may be present The *treatment* of uncomplicated cases is by immobilisation in plaster If sinuses are present in a finger amputation is advisable

CHAPTER VII

DISEASES OF JOINTS

INJURIES OF JOINTS

TRAUMA to a joint results in a traumatic synovitis with effusion into the joint. The joint is swollen and held in a semi-flexed position. Movements are restricted in range due to the pain and to mechanical restriction by the fluid. In the absence of satisfactory treatment muscle wasting rapidly develops leading to recurrent effusion and loss of function.

Treatment consists of the application of a firm pressure bandage to reduce the tendency to further effusion and immobilisation of the limb on a splint for three to four days. Active movements of the muscles are encouraged by immediately using the joints which are not immobilised and static muscle contractions for the muscles controlling the joint are commenced simultaneously. After the splint is discarded active movements of the joint are commenced. These measures preserve the muscle control of the joint and so prevent adhesions and instability. Massage to the joint is avoided.

Wounds of joints are serious injuries because of their liability to be followed by sepsis and destruction of the joint. An X-ray examination is made to reveal the presence of foreign bodies and fractures, whilst anti-shock therapy will be needed in most cases. Local treatment consists of excision of the wound and exploration of the joint. Foreign bodies and bone splinters are removed and the joint cavity then irrigated with normal saline. If the case is operated upon within the first six hours, the synovial membrane is sutured and the wound dusted with sulphonamide powder or penicillin and sulphonamide powder and then loosely packed with vaseline gauze. With later cases the membrane is not sutured. A plaster-cast is then applied to immobilise the joint in the optimum position, the cast being split when dry. Antitetanic serum 3000 units is given to all cases. The

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after treatment resembles the closed plaster treatment of bone infection Static muscle contractions should be practised daily throughout this period to preserve muscle tone. When the wound is finally healed active exercises and heat are given to aid mobilisation

ACUTE INFECTIVE ARTHRITIS

An acute pyogenic arthritis of a joint may result from the introduction of organisms by

(*a*) penetrating wounds of the joint
(*b*) spread from an osteomyelitis of the adjacent bone
(*c*) spread from a septic focus elsewhere via the blood stream *e g* in scarlet fever or pneumonia, or via the lymphatics from a septic abrasion

The causal organism may be a streptococcus staphylococcus aureus pneumococcus or gonococcus

The infection causes an acute inflammation of the synovial membrane In the milder types there is a turbid yellow sero-fibrinous effusion into the joint, the fluid containing polymorphonuclear leucocytes With more severe infections, the synovial membrane becomes injected friable, and thickened whilst the articular cartilage necroses due to pressure from the opposing articular surface erosion by granulation tissue and the action of bacterial toxins and separates from the underlying bone The intra articular ligaments soften and are often destroyed allowing pathological dislocation to occur The joint effusion is purulent and may *rupture through the joint capsule to form a subcutaneous* abscess. When the condition heals, adhesions form between the raw bony articular surfaces these later becoming ossified This results in bony ankylosis of the joint, which is often associated with deformity if treatment has been long delayed.

Symptoms and signs.—The patient complains of intense pain in the joint, aggravated by the slightest movement The joint is swollen, tense and the overlying skin is red and often oedematous, while movement is completely restricted because of muscle spasm

Treatment—Abundant fluids must be administered to

combat the toxaemia and the bowels well opened by means of an aperient

In the early stages the limb is immobilised on a splint with extension applied to separate the bony surfaces and a course of chemotherapy is commenced immediately If the pyrexia persists the joint is aspirated and washed out with saline using a second needle for the effluent the procedure being performed under general anaesthesia If pus is present and the above measures fail to control the infection the surgeon will open the joint and drain it immobilising the joint in plaster of Paris in such a position that function will be good when ankylosis occurs as it inevitably will

The position of optimum function for a hip joint is fixation in a position of 5°–10 flexion very slight abduction and very slight lateral rotation The knee joint is fixed in extension care being taken to avoid hyper-extension The ankle is fixed with the foot at right angles to the leg whilst the shoulder is fixed in 60–70 abduction slight lateral rotation and sufficient flexion so that the elbow is in line with the front of the chest The elbow is fixed in 90 flexion with full pronation for clerical workers and mid pronation for manual workers

GONOCOCCAL ARTHRITIS

Gonococcal arthritis is usually associated with subacute inflammation of the fibrous tissues around the joint and deserves special mention as treatment must be directed towards the cause if cure is to be permanent A search for prostatitis and vesiculitis must be made, and these treated In addition to the treatment of the acute or subacute arthritis (*vide supra*) a mixed gonococcal vaccine is given In the subacute stages diathermy is a valuable means of relieving pain

TUBERCULOSIS OF JOINTS

A tuberculous joint is almost always a secondary infection from a focus elsewhere usually a lymph gland and, as in the case of bone tuberculosis the bovine type of organism accounts for a large proportion of cases

The condition occurs most commonly in childhood and

may infect the joint by forming tubercles in the synovial membrane or by infecting the metaphysis the disease then spreading into the joint The articular surfaces, synovial membrane and ligaments become eroded and a purulent effusion develops Erosion of the ligaments may result in pathological dislocation of the joint. The pus from the joint tracks along vessels and towards the skin, forming abscesses. These may rupture, causing sinuses When the disease becomes quiescent and heals fibrous tissue replaces the granulation tissue in the joint cavity and ankyloses the joint often in a position of deformity Bony ankylosis may occur but is less frequent in adults than in children If however the disease is limited to the synovial membrane and comes under treatment early some movement may remain

Symptoms and signs—The patient first complains of pain in relation to the affected joint, and this may be associated with a diffuse indolent swelling of the joint and periarticular tissues Movement is restricted in all directions by the effusion and by muscle spasm These hold the joint in a position of slight deformity When the articular surfaces are eroded considerable pain is experienced when the spasm relaxes, as in sleep This is due to the ulcerated articular surfaces being rubbed together and causes the night-cries so characteristic of joint tuberculosis Muscle wasting is visible in the affected limb As the disease advances further deformity results from destruction of ligaments and bone Prolonged secondary infection of sinuses may lead to amyloid disease which is always fatal The onset of this terminal complication is heralded by albuminuria and persistent diarrhoea

Mantoux tuberculin tests and X rays are invaluable aids to diagnosis In doubtful cases some fluid is aspirated from the joint and injected into a guinea pig If the guinea pig develops tuberculous lesions within 6–8 weeks a positive result is obtained A negative result does not mean that tuberculosis of the joint is absent, as a negative result may be obtained whilst the disease is limited to the bone near the joint. Occasionally a lymph gland is excised from the group draining the joint and examined microscopically for evidence of tuberculosis

Treatment —1 *General treatment* —This should be exactly the same as that for bone tuberculosis

2 *Local treatment* —Reduction of the deformity must be first obtained and this must be effected gradually Forcible correction is never used as this is liable to spread the disease and cause miliary tuberculosis Correction is obtained by traction, first applied in the axis of the deformity and then deviating gradually towards the axis of the correct position

The joint must be immobilised to ensure rest and resolution of the disease This is obtained by the traction used to correct deformity and by splints When the deformity is corrected the immobilisation is continued by traction on a frame, or immobilisation in a plaster-cast It is maintained until the disease is healed which may take two to three years Operative treatment is indicated only in adults where spontaneous healing is not common operative fusion of the joint being performed by extra articular or intra articular methods By extra articular fusion we mean fixation of the joint by a bony bridge between the bones forming the joint without opening the joint Intra articular fusion is used chiefly for the knee joint. When multiple infected sinuses are present amputation may be necessary When the disease is healed ambulatory treatment is commenced the joint being protected by a caliper or brace Later operative measures may be needed to correct deformities osteotomy being the operation commonly used

TUBERCULOSIS OF THE HIP JOINT

Tuberculosis of the hip joint has an insidious onset the first indication of its presence usually being pain in the hip and knee the latter being due to referred pain along the obturator nerve which gives sensory branches to both hip and knee joints This is very soon accompanied by the appearance of a limp due to slight deformity The latter is due to swelling of the joint tissues and muscle spasm, causing the leg to be held in flexion abduction and external rotation As the articular cartilage becomes eroded the pain increases and the deformity changes to adduction internal rotation and flexion as a result of destruction of bone (Figs 157(*a*)

may infect the joint by forming tubercles in the synovial membrane or by infecting the metaphysis, the disease then spreading into the joint The articular surfaces synovial membrane and ligaments become eroded and a purulent effusion develops Erosion of the ligaments may result in pathological dislocation of the joint The pus from the joint tracks along vessels and towards the skin forming abscesses These may rupture causing sinuses When the disease becomes quiescent and heals, fibrous tissue replaces the granulation tissue in the joint cavity and ankyloses the joint, often in a position of deformity Bony ankylosis may occur but is less frequent in adults than in children If however, the disease is limited to the synovial membrane and comes under treatment early some movement may remain

Symptoms and signs —The patient first complains of pain in relation to the affected joint, and this may be associated with a diffuse indolent swelling of the joint and periarticular tissues Movement is restricted in all directions by the effusion and by muscle spasm These hold the joint in a position of slight deformity When the articular surfaces are eroded, considerable pain is experienced when the spasm relaxes as in sleep This is due to the ulcerated articular surfaces being rubbed together and causes the night-cries so characteristic of joint tuberculosis Muscle wasting is visible in the affected limb As the disease advances further deformity results from destruction of ligaments and bone Prolonged secondary infection of sinuses may lead to amyloid disease, which is always fatal The onset of this terminal complication is heralded by albuminuria and persistent diarrhoea

Mantoux tuberculin tests and X rays are invaluable aids to diagnosis In doubtful cases some fluid is aspirated from the joint and injected into a guinea pig If the guinea pig develops tuberculous lesions within 6–8 weeks, a positive result is obtained A negative result does not mean that tuberculosis of the joint is absent, as a negative result may be obtained whilst the disease is limited to the bone near the joint Occasionally a lymph gland is excised from the group draining the joint and examined microscopically for evidence of tuberculosis

when the hip is ankylosed When the deformity is reduced and bone destruction is present the traction may be discontinued and the limb immobilised in a hip plaster spica for a period of 18 months to 2 years In the convalescent stages a Thomas hip splint and patten is worn For adult cases an iliofemoral or ischiofemoral arthrodesis may be necessary to ensure a permanent bony ankylosis (Figs 160(*a*) and (*b*))

For the operation of iliofemoral arthrodesis a window is cut in the spica plaster which has been previously applied the plaster being removed over the iliac crest dorsum ilii and greater trochanter A bone graft is cut from the antero-medial aspect of the tibia and inserted into grooves cut in the great trochanter and ilium A flap of bone is often turned down from the dorsum ilii to aid stability and fixation of the graft

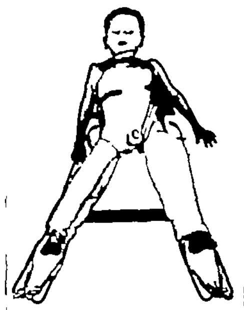


Fig 158 Tuberculosis of the hip treated on a Jones abduction frame

After the wound has been closed and dressings applied the window is closed with plaster The spica cast is left untouched for 3–4 months when bony fusion should be complete After treatment then consists in re-education of walking and active exercises to increase knee mobility as this is often restricted by the long immobilisation

An ischiofemoral arthrodesis is to be preferred as the operation is not so likely to affect diseased tissue since the main channel of spread of the disease is upwards Further it produces a more sound fixation than the iliofemoral type of operation and allows simultaneous correction of any *adduction deformity* For the operation the patient is placed on an orthopaedic table with slight traction applied to both legs After subtrochanteric osteotomy of the femur

and (b)) Pathological dislocation may occur because of destruction of the periarticular ligaments and erosion of the acetabulum The head of the femur then rests upon the ilium and the erosion of the latter produces the appearance of a new acetabulum Hence the term travelling acetabulum



(a)



(b)

Fig 157—(a) Front view of a boy with tuberculosis of the right hip Note the abduction and eversion and the apparent lengthening of the leg (b) A lateral view of the same child showing the flexion of the hip

Treatment.—The hip should be immobilised and traction applied to correct any deformity by means of a Jones abduction frame (Fig 158) or a Pugh hip frame (Fig 159) the traction being exerted so that the final position of the limb is that of slight flexion and abduction and external rotation. This position is the most favourable for walking

TUBERCULOSIS OF THE KNEE

Initially tuberculosis of the knee joint is often of the synovial type The knee is swollen and held in a semi flexed position because of muscle spasm and the effusion in the joint the swelling being more prominent because of muscle wasting Advanced cases exhibit pathological dislocation of the knee as a result of destruction of the cruciate ligaments the knee being flexed and displaced backwards with external rotation of the leg on the thigh due to the action of the biceps femoris muscle

Treatment in the case of children should always be conservative, and consists of traction on a Thomas bed knee

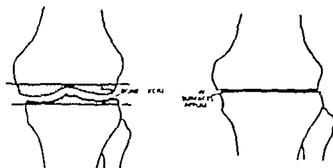


Fig 101 Arthrodesis of the knee

splint or immobilisation in a plaster spica the knee being maintained in a position of 5 flexion A walking caliper is worn in the convalescent stage In adults excision and arthrodesis is performed after a period of traction when the acute stage is passed (Fig 101) The operation is performed with the aid of a tourniquet as blood loss is minimised and a bloodless operative field provided It consists of excision of the articular surfaces of the femoral condyles upper end of the tibia and patella by saw cuts followed by excision of the synovial membrane Some surgeons insert excision pins to maintain apposition of the raw surfaces of the bones but there is considerable danger in their use as sepsis may easily track along the pins from the exterior and infect the bone The limb is immobilised in a plaster hip spica until the arthrodesis is firm (approximately 3–6 months) and then a walking caliper is worn for a further period of six months General treatment must be continued during this period

a large tibial graft is cut and inserted between the femoral fragments so that it enters a groove cut in the ischium The

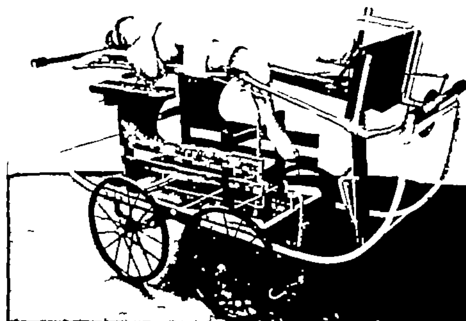


Fig 159 —Pugh hip extension frame The sound limb is being exercised

preparation of this groove and the insertion of the graft are all performed under X ray control The operation is com

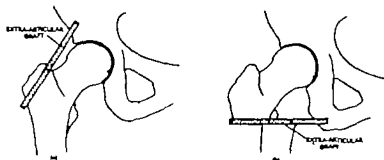


Fig 160 —Arthrodesis of the hip (a) Ilio-femoral type the graft bridging the ilium and great trochanter (b) Ischio-femoral. The graft is inserted between the upper and lower fragments of the femur following a subtrochanteric osteotomy and inserted into a groove cut in the ischium. This operation will also correct any coincident adduction deformity

pleted by application of a single hip spica, which is retained for at least three months

the congenital form A gummatous arthritis may occur in the tertiary stage of syphilis the synovial membrane being thickened and infiltrated with multiple gummata The symptoms and signs resemble tuberculosis of a joint but pain is not so marked The Wassermann reaction is positive and the condition responds to antisyphilitic treatment especially the exhibition of potassium iodide The joint is immobilised in the optimum position for ankylosis as the joint usually recovers with restriction of movement

NEUROPATHIC JOINTS (CHARCOT S JOINTS)

Charcot s joints occur in tabes peripheral neuritis transverse myelitis, and syringomyelia The pathological process

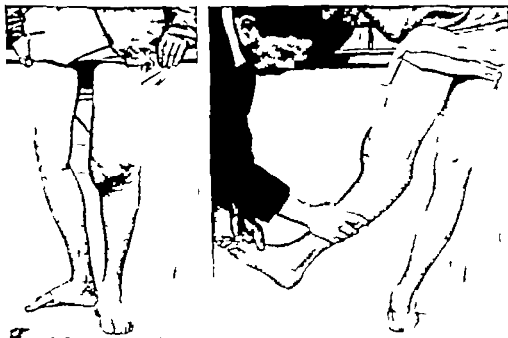


Fig 102.—Charcot s joint showing the abnormal mobility

is not due to syphilis *per se* but is a result of trauma to a joint where some degree of anaesthesia is present as a result of the nerve lesion They usually occur during and after middle age and are characterised by the appearance of a rapidly increasing painless effusion into a large joint such as the knee shoulder or elbow There is excessive mobility of the joint which leads to instability (Fig 102) The

TUBERCULOSIS OF THE UPPER EXTREMITY

The upper extremity is not so commonly affected by tuberculosis in children but often is in adults and is then frequently associated with pulmonary tuberculosis *For shoulder disease* immobilisation is provided by means of a plaster shoulder spica As bony ankylosis is rare an extra articular arthrodesis is often performed by fixing the acromion process to the greater tuberosity A plaster spica is applied with the arm abducted 60 rotated laterally and flexed so that the elbow is in line with the front of the chest, and retained until union is sound Fixation in this position will allow the rotation of the scapula to compensate to a considerable degree for the loss of shoulder movement.

Tuberculosis of the wrist and elbow are treated by immobilisation in plaster with the joints fixed in the optimum position as for ankylosis after acute infective arthritis Amputation is often needed in elderly subjects, because of the progressive toxaemia, wasting and sinuses

SYPHILIS OF JOINTS

Congenital—(*a*) *Syphilitic epiphysitis* occurs in infants during the first few months of life The limb becomes swollen and tender and suppuration of the epiphysis may occur The latter may even separate from the diaphysis causing a sensation of crepitus on palpation A Wassermann reaction should be taken from the mother or the infant it will be positive in the majority of cases The condition resolves with general antisyphilitic treatment, but the affected limb is immobilised until the epiphysitis has subsided and there is no further risk of separation or displacement of the epiphysis

(*b*) *A bilateral painless effusion* into the knee-joint is a frequent occurrence in adolescent sufferers from congenital syphilis On aspiration of the joint a sterile straw-coloured fluid containing lymphocytes will be obtained The effusion subsides with rest in bed and general antisyphilitic remedies

Acquired—A bilateral painless effusion may occur in the late secondary stage which is identical with that occurring in

Treatment—Treatment is usually in the hands of a physician and the general treatment is largely medical. Measures used consist of injections of gold salts, vaccines and the removal of septic foci. *It is essential, however, that an orthopaedic surgeon should co-operate in the treatment from the commencement if a successful result is to be achieved.* The aim of any treatment of the condition must be

(i) to *prevent* contractures which produce deformity
(ii) to relieve pain and aid recovery of the joint
(iii) to leave the patient with a useful joint, *i.e.* a painless joint where some degree of movement is possible

To these must be added later measures designed to increase movement or provide stability. For all these orthopaedic surgery is necessary but it is regrettable that many patients come to the orthopaedic surgeon in the later stages of the disease seeking relief of established deformity.

In the acute and subacute stages, the joints should be splinted in the optimum position which will rest the joints and prevent stretching of any muscle groups. Light removable plaster splints which will allow physiotherapy to be given are provided for all affected joints. The physiotherapeutic measures consist of short wave therapy, diathermy or infra-red radiation. The joints should be put through a range of passive movements and, if possible, active movements undertaken each day to prevent formation of adhesions. Traction is beneficial in the presence of muscle spasm and severe pain and the methods used resemble those for tuberculosis of joints.

Operative measures in the early stages are rarely indicated although sympathetic ganglionectomy may have a beneficial effect by increasing the blood supply to the joints. Synovectomy is useful in the knee joint when there is a large persistent effusion and thickened synovial membrane associated with considerable restriction of movement. The after-treatment of this operation consists of immobilisation in a plaster-cast for six weeks, followed by mobilisation exercises.

Later treatment is directed to the relief of pain and deformity, and when a large joint is affected, causing considerable pain and stiffness, arthrodesis is a satisfactory

articular surfaces show evidence of gross destruction whilst new bone forms in the joint capsule and periarticular tissues.

Treatment.—This consists of stabilising the joint either by an arthrodesis operation or by wearing an appliance such as a walking caliper or brace Arthrodesis is often un successful because the bone is usually avascular Amputation may be necessary if stability cannot be obtained by the above measures, particularly when the ankle joint is affected

RHEUMATOID ARTHRITIS

Rheumatoid arthritis is a common crippling affection of young adults It affects the small joints chiefly especially



FIG. 103.—Deformities of the hands due to rheumatoid arthritis.

the metacarpo-phalangeal and tarsal joints, and affects many joints simultaneously The synovial membrane of the joint proliferates and spreads over the articular cartilage, causing swelling of the joint An addition to the swelling is provided by the periarticular tissues becoming swollen and oedematous The joints thus appear spindle shaped, and the skin over them is bluish red in colour The local condition is accom panied by general evidence of a subacute arthritis *i e* pyrexia sweating and an increase in the pulse rate and blood sedi mentation rate The patient is often anaemic and has the typical appearance produced by toxaemia. If untreated muscle wasting and spasm produce deformities which ultimately become permanent Joint destruction results in painful *restricted movement and further deformity* (Fig 103)

relief Deep X ray therapy is now being used with increasing frequency with good results When one large joint is severely affected, arthrodesis is often performed as no joint is better than a useless painful joint Arthroplasty gives very satisfactory results when many joints especially both hips are affected

OSTEO ARTHRITIS OF THE HIP

The deformity resulting from osteo-arthritis of the hip is that of adduction internal rotation and flexion thus causing the patient to limp Operative measures are often necessary as the condition often recurs after conservative measures



Fig 164 —Roller-skate exercises after acetabuloplasty The degree of tilt of the wooden board can be varied to provide gravity assisted or gravity resistance exercises

Arthrodesis is performed in young patients with affection of one hip If both hips are affected a vitallium cup acetabuloplasty may be performed In this operation the articular surfaces of the head of the femur and acetabulum are reshaped with reamers and a vitallium cup placed between the surfaces (Fig 164) After operation the limb is immobilised by Hamilton Russell balanced traction for four weeks Daily passive and assisted active movements of the hip are allowed and after four weeks the traction is removed and the patient allowed up with crutches and full weight bearing and non weight bearing exercises allowed (Fig 165)

In older subjects a McMurray osteotomy affords relief from pain whilst retaining hip movement and correcting deformity The femur is divided under X ray control just

measure Arthroplasty does not give very good results because of the changes in the periarticular tissues, which restrict movement and cause pain but is often used when multiple joints are affected Manipulation may be used for painful adhesions when the disease is quiescent This stage is indicated by a persistently low blood sedimentation rate.

Established deformities may be corrected by manipulation, traction tenotomies and osteotomies when the disease is quiescent

OSTEO-ARTHRITIS

Osteo-arthritis is a degenerative condition of a joint, usually a large joint which occurs most commonly in middle-aged subjects Trauma is a large factor in the production of osteo-arthritis, especially after fractures involving the joint surfaces or where mal alignment increases the strain borne by the joint Previous osteochondritis of epiphyses is often the predisposing factor In many subjects osteo-arthritis is evidence of the advancing years, and is purely a senile change

The joint cartilage degenerates and pressure between the articular surfaces compresses and erodes the soft cartilage. The bone underneath becomes condensed and dense Out growths of cartilage at the joint margins form osteophytes, and these may become detached and form loose bodies in the joint The degeneration and erosion of the cartilage cause narrowing of the joint space and this is evidenced by X ray examination of the joint

The patient complains of pain and stiffness in the affected joint, usually worse in the morning after resting and in wet weather The stiffness often decreases after the patient has been up and about for a few hours Deformity may be present because of muscle spasm On examination, some degree of swelling of the joint is evident, and crepitus is felt when the joint is put through its restricted range of movements

Treatment —A search is made for septic foci and these removed Deformity is corrected by traction or tenotomies or osteotomies Intensive physiotherapy is given, and these measures, combined with rest and traction, afford considerable

occur in inflammatory conditions such as tuberculosis and after the organisation of an intra-articular haemorrhage following trauma. *Cartilaginous* and *osteo cartilaginous* loose bodies may develop in

(*a*) osteo-arthritis when an osteophyte becomes detached

(*b*) osteochondritis dissecans when a piece of articular cartilage necroses and becomes detached and lies free in the joint

(*c*) multiple loose bodies may be due to synovial chondro-



FIG 106 — X ray photograph of loose bodies in the knee joint resulting from osteochondritis dissecans

mata a condition where the synovial membrane is studded with numerous sessile and pedunculated osteo-cartilaginous bodies

Bony loose bodies may result from injury detaching osteophytes or small pieces of articular surface with pieces of underlying bone. Loose bodies cause repeated locking of the affected joint followed by the appearance of an effusion. The locking is accompanied by pain the site of the pain and the degree of flexion of the joint varying with each locking because the loose body moves about in the joint. With repeated attacks the pain and swelling become

above the lesser trochanter and the shaft moved inwards under the neck of the femur for one inch The limb is then immobilised in a hip spica for twelve weeks the patient being allowed up with crutches meantime After removal of the plaster full weight bearing exercises are allowed concen



FIG 163 —X ray photograph showing vitallium cup in situ.

trating upon re-education of walking and posture, and mobilisation of the knee and hip

LOOSE BODIES

Loose bodies occurring in joints may be cartilaginous, fibrous fibrinous, or bony *Fibrous* or *fibrinous* loose bodies

muscle is contracting The patient experiences a sudden severe pain in the anterior aspect of the arm followed by considerable ecchymosis and swelling Attempts to flex the elbow are painful ineffective and are accompanied by the appearance of a swelling in the upper half of the arm, due to the upper part of the muscle contracting without any resistance Suture of the muscle belly is necessary to restore the function of the muscle

(*b*) **The tendon of the long head of biceps** may rupture in an old patient who has osteo arthritis of the shoulder joint. This may cause attrition of the tendon as it passes in the groove in the humerus, and slight violence may then be followed by rupture of the tendon There is a sudden snapping sensation located in the shoulder followed by pain in the shoulder especially when the elbow is flexed or supinated and the muscle belly is more prominent and lower on the affected side The rupture is treated by suture of the tendon or by suture of the distal part to the short head of the biceps

(*c*) **The supraspinatus tendon** —The supraspinatus tendon forms the roof of the shoulder joint and is inserted into the greater tuberosity of the humerus Its action is to hold the head of the humerus to the glenoid cavity when the movement of abduction of the shoulder begins

The tendon may be torn from its insertion or ruptured in dislocations of the shoulder joint or by a direct blow over the tendon The patient complains of pain in the shoulder and cannot abduct the arm normally unless he is assisted for the first 30 –40 of the movement. If the abducted arm is gradually lowered below 90° the patient experiences severe pain and the arm falls to the side because of reflex inhibition of the abductor muscles (Fig 167)

The tear must be repaired by suture followed by immobilisation of the arm on an abduction frame for four weeks Active exercises are then commenced and the abduction frame removed when active abduction to 140 is possible

Calcification of the supraspinatus tendon is a condition where calcified deposits are found in the tendon and insertion of the supraspinatus muscle There is invariably a history of previous injury to the shoulder region which is followed

less and the ease with which unlocking is obtained increases Muscle wasting occurs, and causes a sense of weakness in the joint

Treatment —Loose bodies causing symptoms are removed by operation After treatment consists of active exercises designed to restore the muscle control of the joint

SPECIAL INJURIES AND AFFECTIONS OF THE SHOULDER-JOINT

When a joint is injured, the movements which are chiefly affected and which are recovered with difficulty are those which have been acquired most recently during the process of evolution In the shoulder joint, lateral rotation and abduction are the most recent acquisitions and these movements are affected most in shoulder injuries Thus in the treatment of these injuries, the joint should be immobilised in abduction and external rotation

SPRAIN OF THE SHOULDER JOINT

A sprain of the shoulder joint may follow a sudden wrench and is accompanied by extravasation of blood into the periarticular tissues and the appearance of an effusion in the joint. Pain is felt down the arm and over the shoulder Treatment consists of resting the arm on an abduction frame, accompanied by active and passive movements of the joint to prevent the formation of adhesions and to retain muscle control Radiant heat or diathermy should be applied liberally The frame is removed when the arm can be actively abducted to 140 If adhesions are present, a manipulation under general anaesthesia will benefit the patient, but it must be followed by a course of active shoulder exercises

MUSCULAR INJURIES

(*a*) **The biceps** —Rupture of the muscle belly of the biceps may occur following sudden extension of the arm when the

the mere anaesthetic action and accelerates resolution When the condition has become chronic curettage of the calcified mass affords the speediest cure

SUBDELTOID BURSITIS

Subdeltoid bursitis is associated with pain and swelling in the deltoid region of the shoulder and painful abduction It is treated by rest upon an abduction frame and local physiotherapy heat in the form of short wave diathermy or infra red radiation being most valuable General measures such as attention to the bowels and removal of septic foci are important factors in aiding recovery

PERIARTHRITIS OF THE SHOULDER

Periarthritis of the shoulder is a syndrome where one definite shoulder movement is restricted at first because of periarticular adhesions Trauma is not a common factor in the aetiology but septic foci are usually present Later other movements become restricted producing the frozen shoulder General treatment is aimed at the elimination of toxins by purgation the administration of liberal fluids and removal of septic foci Locally active exercises should be supplemented by heat given by infra red radiation or short wave diathermy Manipulations under anaesthesia are *invaluable means of improving movement and function* Only one movement should be increased at each manipulation otherwise a severe reaction may result and produce an increase of the stiffness

BRACHIAL NEURITIS '

Brachial neuritis is a term loosely applied to pain in the shoulder and arm It may be due to any of the above conditions to a cervical rib or to fibrosities of the neck muscles, trapezius or muscles of the shoulder girdle to

sometimes after a considerable interval of time by pain and stiffness in the shoulder The pain is worse at night and is aggravated by abduction of the arm An X ray examination



FIG 167 —The function of the supraspinatus is to fix the head of the humerus while the deltoid abducts the arm If the tendon is ruptured or avulsed, the deltoid pulls the head of the humerus upwards. Weak scapular rotation abduction to 40 -60 is possible

will reveal the presence of calcification of the tendon. (Fig 168)

In the acute stage, the arm is immobilised on an abduction



FIG 168.—Calcification of the supraspinatus tendon

frame with the application of heat by infra red ray or short wave therapy Injection of the tendon and its insertion with 2 per cent. novocaine affords considerable relief beyond

ACUTE TRAUMATIC SYNOVITIS

Acute traumatic synovitis of the knee joint resembles synovitis in any other joint but in the knee particular care is taken to preserve the function of the quadriceps muscle if chronic disability is to be avoided This muscle group rapidly wastes unless active exercises are commenced immediately treatment is started The limb should be rested in bed and a firm U shaped pad and crêpe bandage placed over the supra patellar pouch Quadriceps drill is practised daily Resolution and return to full function varies with the severity of the injury the minimum period being 2–3 weeks

TORN MEDIAL COLLATERAL LIGAMENT AND FIBULAR COLLATERAL LIGAMENT

Tears of these ligaments are due to forcible abduction and adduction of the knee not associated with rotation of the tibia or the femur Partial tears are common They are associated with pain accentuated by stretching the ligament by manual abduction or adduction and with tenderness over the origin or insertion of the ligaments into the condyle of the femur or tibia and fibula An abnormal degree of abduction or adduction is not found as in a complete tear

Treatment consists of the application of a plaster from the ankle to the groin, so as to allow walking and to prevent any lateral strain on the knee joint. Quadriceps exercises are commenced immediately The plaster of Paris is removed after fourteen days and full active movements of the knee commenced

Complete tears are associated with marked instability of the knee-joint and abnormal abduction or adduction mobility is present, while there is tenderness along the ligament Conservative treatment is on similar lines to that for a partial tear but immobilisation is continued for six weeks Repair rarely occurs by conservative methods but if active quadriceps drill and ambulatory treatment is used the muscles may control the knee sufficiently to allow a sedentary worker

osteo-arthritis of the cervical spine, or to ankylosing spondylitis affecting the cervical spine Treatment is directed to the underlying lesion True neuritis of the branches of the brachial plexus causes partial paralyses of the nerves Treatment is similar to that for traumatic peripheral nerve lesions

TENNIS ELBOW

Tennis elbow is the name given to a painful condition of the lateral aspect of the elbow common after playing certain games such as tennis or golf The exact pathology is unknown It is thought by some surgeons to be due to an inflammation of an adventitious bursa present between the origin of the common extensor muscles of the hand and forearm and the lateral epicondyle of the humerus Others think it to be due to adhesions following a partial tear of these muscles

The patient experiences pain and tenderness over the lateral epicondyle during active movements of the elbow

The surgeons who believe in the bursitis theory operate on these cases to remove the bursa Others manipulate the elbow to break the adhesions the elbow being extended with the arm pronated and the wrist flexed This effectively stretches the extensor muscles After manipulation a course of massage sinusoidal baths and active elbow exercises is prescribed

SPECIAL AFFECTIONS OF THE KNEE-JOINT

The peculiar anatomy of the knee-joint renders it particularly liable to mechanical derangements which interfere with the function and stability These are often known as internal derangements, a term originally applied to them by William Hey of Leeds in 1803

The symptoms and treatment of acute arthritis and wounds of joints in general have been discussed and the same principles are applicable to the knee-joint.

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to carry on his employment For others whose work is more strenuous further measures will be required to control the instability This may be done by wearing a knee cage to limit lateral movement or by an operation designed to reconstruct a new ligament, using fascia lata for the fibular collateral ligament and the deep fascia or medial hamstring tendons to replace the medial ligament. It is important that daily quadriceps drill be instituted the day after operation Other exercises which are used after this and other knee operations are

(1) Dangling the legs over the bed and alternately extending and flexing each knee
(2) Raising the extended leg by flexing the hip whilst lying flat, and then abducting and adducting the hip This exercises all the thigh and buttock muscles
(3) Bicycling—stationary and otherwise This should be introduced very gradually otherwise an effusion may appear

TORN CRUCIATE LIGAMENTS

The cruciate ligaments are strong fibrous structures attached to the intercondylar notch of the femur and the tibial spine They prevent antero posterior movement of the tibia on the femur The anterior cruciate ligament is taut when the knee is extended and the posterior ligament is taut when the knee is flexed They are only injured by severe trauma and, when torn, damage to the joint capsule and other joint structures is bound to be present, *e.g* fracture of the spine of the tibia.

The injury is either forcible hyper extension of the knee, such as a weight falling on the unsupported extended knee or a fall on to the flexed knee There is marked swelling of the knee, due to intra articular haemorrhage and abnormal antero-posterior mobility of the joint is present. Old tears cause instability of the knee the knee frequently letting the patient down because of defective muscle control of the joint.

Treatment consists of *immobilisation in plaster of Paris* from the toes to the groin after aspiration of the haemorrhagic effusion *Quadriceps drill is commenced immediately* The plaster of Paris is removed after six weeks, and full active knee exercises commenced *Repair is not common but good* muscular development will allow useful function and considerable stability in most cases

In old cases the aim should be to improve the muscular control If instability is still present a knee cage is worn thus restricting the abnormal mobility and also knee movement *Operations to reconstruct the ligaments* using fascia lata or semitendinosus tendon are seldom advisable as the new ligaments stretch and the disability persists

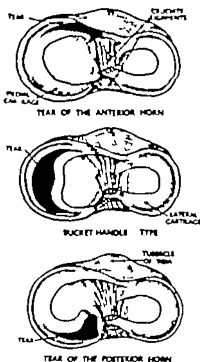


Fig 100 —*Three types of tear of the medial semilunar cartilage*

INJURIES OF THE SEMI LUNAR CARTILAGES

Tears and displacements of the semilunar cartilages are common injuries of the knee joint the medial cartilage being damaged ten times *more often than* the lateral cartilage The injury is particularly *common in* foot ballers and in miners (Fig 100)

The medial cartilage is torn by a sudden extension of the knee, from a position of external rotation abduction and flexion of the tibia on the femur The cartilage is nipped between the articular surfaces as the femur tends to pull the cartilage laterally away from its attachment to the medial collateral ligament This results in the cartilage being torn transversely at any point, or it may be split longitudinally so that the mobile part dislocates into the joint between the bony articular surfaces and causes locking In locking extension is suddenly limited at a certain degree of flexion

and the joint cannot be extended by manual force The knee joint is swollen because of a serous effusion and painful, and the patient usually cannot bear weight on the leg Tenderness can often be elicited over the antero medial aspect of the joint The dislocation is reduced by manipulation under anaesthesia and the limb should then be immobilised on a back splint with a pressure bandage applied to the joint. Quadriceps drill is instituted on the same day Full knee movements are allowed on the tenth day and weight bearing exercises commenced on the fourteenth day The inner side of the shoe and heel is wedged $\frac{3}{16}$ in to prevent abduction and lateral rotation strain at the knee, and exercises are continued until muscle function equals that of the unaffected leg

If the after treatment is not carried out, the quadriceps muscle wastes considerably leading to constant weakness of the knee The patient then complains of the knee repeatedly letting him down The treatment should then be directed to improving the muscle control of the knee-joint.

In recurrent cases, excision of the whole cartilage by operation is necessary A tourniquet is used to prevent haemorrhage obscuring visibility and to avoid constant swabbing of the joint. An absolute no touch technique is essential After the joint is closed a firm wool layer bandage is applied, before removal of the tourniquet, using alternate layers of wool and bandage This controls haemorrhage The tourniquet is then removed, but no splint is applied.

Faradism to the quadriceps and quadriceps drill is commenced the day after operation The sutures are removed on the ninth or tenth day and the patient allowed up on the fourteenth day Full active knee exercises are then practised Weight and pulley exercises are very valuable in restoring normal function but must be cautiously introduced if effusion is to be avoided.

Lateral cartilage injuries are due to internal rotation of the adducted and flexed knee giving similar symptoms, but locking is not common There is often a click heard when a certain degree of flexion is passed, and this together with weakness of the joint, is the chief symptom Treatment is similar to that for a medial semilunar cartilage injury

Discoid lateral cartilage —Occasionally the lateral cartilage is a complete disc instead of being semicircular It is usually bilateral The condition is associated with a loud clicking sound when the joint is flexed or extended some pain in the lateral aspect of the joint and weakness of the knee The cartilage is excised if symptoms are present

Cysts of the semilunar cartilage appear as rounded cystic swellings on the lateral or medial aspects of the joint arising from the semilunar cartilage the lateral cartilage being more commonly affected than the medial cartilage There is usually a previous history of trauma although some surgeons think that the cysts are congenital in origin Locking is rare and often the only complaint is the presence of the swelling

Treatment —The cyst and the whole cartilage must be excised to guarantee cure The after treatment is the same as that following excision of a torn cartilage

AFFECTIONS OF THE INFRAPATELLAR PAD OF FAT

The infrapatellar pad of fat lies between the infrapatellar ligament and the synovial membrane of the anterior aspect of the knee joint When the knee is extended the pad of fat is pulled up together with the patella and in this manner nipping of the pad between the articular surfaces of the femur and tibia is prevented If the pad should be increased in size or if the quadriceps be weak nipping commonly occurs This causes haemorrhage into the pad of fat and further enlargement Enlargement of the pad is common in rheumatoid arthritis

The patient complains of pain when extending the knee especially when going up and down stairs The nipping often results in effusion and quadriceps wasting and this leads to a sense of weakness in the knee When the knee is examined a tender puffiness is found in either side of the infrapatellar ligament Active and passive movements of the knee joint are usually normal except for the last 15 –20 of extension when pain is experienced behind the infrapatellar ligament

Treatment—Raising the heel of the boot ⅛ in. to prevent full extension of the knee often allows the swelling to subside in traumatic cases This treatment should be supplemented by quadriceps exercises and faradism In severe cases, a knee cage may be needed to limit extension by 20–30 If the condition persists or recurs after conservative treatment operative removal of the pad of fat is undertaken

RECURRENT DISLOCATION OF THE PATELLA

The patella may be dislocated medially or laterally and this may be due to trauma alone or to defects in the knee which allow the patella to dislocate with a slight injury



FIG. 170—Osteotomy and insertion of a bone wedge to elevate the lateral femoral condyle

The latter lead to recurrent or habitual dislocation of the patella, and this is usually lateral in direction The case

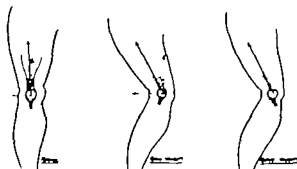


FIG 171—Medial transplantation of the ligamentum patellae corrects the lateral deviation pull of the quadriceps.

with which dislocation recurs is due to (1) the lateral femoral condyle being poorly developed and the patella lying antero-laterally (Figs 170 and 171) or (2) the presence of genu

varum often rachitic in origin which increases the tendency for the quadriceps to pull the patella laterally when contracting

The patella in such cases dislocates during a sudden contraction of the quadriceps when the knee is almost fully extended and the foot everted There is pain and swelling of the knee and the joint is fixed in a semi flexed position with the patella lying on the lateral aspect of the joint With each recurrence dislocation occurs and reduction is obtained with increasing ease and the joint becomes weak relaxed and unstable Reduction is obtained by relaxing the quadriceps by flexing the hip and extending the knee The patella is then easily manipulated back into position The inner sides of the shoes should be raised in order to prevent any tendency to abduction at the knee and quadriceps exercise and faradism given Recurrent dislocation is an indication for operative treatment Many operations have been devised to prevent recurrence of the dislocation Firstly any but slight degrees of genu varum must be corrected If the lateral condyle is defective, it may be elevated and graft inserted This is combined with soft tissue operations The principle of these is to align the patella the line of pull of the quadriceps and patella insertion by moving the patella ligament with a piece of bone to a new insertion on the antero-medial aspect of the upper end of the tibia After operation the limb is immobilised in plaster of Paris for six weeks Quadriceps drill is performed daily When the plaster of Paris is removed active knee movements are encouraged by remedial exercises and weight and pulley exercises as performed after operations for torn cartilage

The operation of excision of the patella is now tending to replace the above operations and the after treatment is identical with that following excision of the bone for fracture

CHAPTER VIII

AFFECTIONS OF THE SOFT TISSUES

GANGLION

A GANGLION is a cystic rounded swelling situated in relation to tendon sheaths and joints, being commonly found at the wrist and over the dorsum of the foot The cyst contains thick gelatinous, clear fluid It is thought to be due to a mucinous degeneration of fibrous tissue related to joints and tendons, or a degeneration of a benign hyperplasia of the synovial membrane or tendon sheath

Treatment.—Conservative measures consist of aspiration and injection of the cyst with sterile collodion This produces an aseptic reaction with obliteration of the cyst. Operative treatment is undertaken when the above fails, or when the cyst is multilocular It consists of excision of the whole cyst wall

AFFECTIONS OF BURSAE

A bursa is a closed sac lined with endothelium and contains a fluid resembling synovial fluid Some are constantly present, whilst others develop only as a result of irritation The latter are known as adventitious bursae, and common examples are the bursae over exostoses or over the tendo-Achilles at the heel

Traumatic bursitis—A blow over a bursa results in a serous or haemorrhagic effusion into the bursa This quickly subsides with aspiration and the application of a firm bandage If trauma is repeatedly applied as in occupational trauma a chronic swelling and thickening of the bursa occurs Common examples are housemaid's knee (enlargement of the prepatellar bursa) and miner's elbow (olecranon bursitis) Infection may be superadded The chronic bursa needs excision

Infective bursitis – Infective bursitis may be *pyogenic* in origin and resembles acute inflammation elsewhere the prepatellar and olecranon bursae being most commonly affected Treatment consists of incision and drainage

Tuberculous or *syphilitic* bursitis may occur and affect the subdeltoid and prepatellar bursae The bursa is thickened and has a doughy consistency on palpation The tuberculous bursa calls for excision whilst antisyphilitic measures are given for the luetic type Chalky deposits in a swollen bursa occur in gout

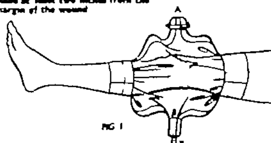
AFFECTIONS OF MUSCLE AND FASCIA

Wounds of muscle need early excision of the damaged skin and muscle in a similar manner to compound fractures as damaged and dead muscle left *in situ* forms an excellent culture medium for organisms

Three thousand units of antitetanic serum is given to all cases When the patient has recovered from shock sufficiently to withstand operative measures, the wound is excised cutting away dead skin and muscle gradually until healthy muscle which contracts and bleeds freely is reached Counter incisions may be necessary for drainage The wound is dusted with penicillin and sulphonamide powder or sulphonamide powder alone and lightly packed with vaseline the limb being immobilised in plaster Changing of the plaster is performed only when it crumbles and becomes soft with discharge The wound heals by granulations, and when these are clean and healthy the plaster is discarded and the wound prepared for skin grafting by cleansing the wound and reducing infection to a minimum by lavage in an irrigation envelope Small wounds are often found to be healed when the plaster is removed

A modified method is to treat the excised wound immediately by repeated irrigation with electrolytic sodium hypochlorite (E S H) For this a Bunyan Stannard irrigation envelope, such as is used for the treatment of burns is applied to the limb and three-hourly irrigation with 10 per cent E.S H at 100 F commenced (Fig 172) The concentration

is reduced to $2\frac{1}{2}$ per cent when the wound is clean and finally to 1 per cent. When the wound is granulating well, skin



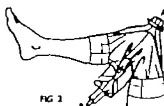




FIG 172 —Instruction diagram for irrigation treatment. (Bunyan-Stannard.)

grafting can be undertaken this step being performed as early as possible to prevent scarring and contractures, which

tend to occur when the wound is allowed to heal by granulation alone

Closed muscle injuries, i e contusions —The bruised area is firmly strapped with elastic strapping for a few days so that the muscle is not overstretched, and physiotherapy is then commenced

RUPTURE OF A MUSCLE

Rupture of a muscle occurs when it is forcibly stretched whilst contracting The muscle ruptures at the junction of the belly with the tendon or in the belly itself Partial or complete ruptures are encountered A haematoma develops between the torn ends, and a swelling appears above the normal position of the muscle belly due to the contracted unattached belly (Fig 173) The patient complains of considerable pain in the muscle which is accentuated when he tries to use the limb

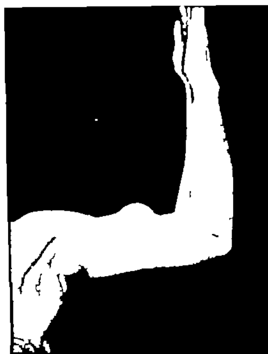


Fig 173.—Rupture of the biceps muscle

Treatment of the partial rupture consists of immobilisation of the limb by a sling or splint, so as to rest the muscle After 10–14 days this is removed and physiotherapy commenced massage and heat being specially indicated

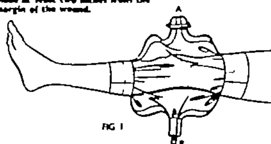
The complete rupture needs exploration and suture of the muscle after evacuation of the haematoma The limb is then immobilised in such a position that the muscle is relaxed For example after suture of the biceps muscle the elbow is held flexed and supinated by a collar and cuff

is reduced to 2½ per cent when the wound is clean and finally to 1 per cent When the wound is granulating well skin

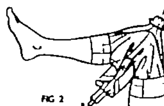
1 Fitting the Envelope (KNEE)

IMPORTANT

In all cases the seal should be made at least two inches from the margin of the wound.



Slide the envelope into the required position on the limb, taking care that the inlet (A) is always on top. The outlet (B) will then be in the correct position.
The envelope is sealed above and below the knee. When fitting full allowance should be made for the knee when bent (Fig 2) to prevent any strain on the envelope and to allow complete freedom of movement.
It can also be used to envelop areas above or below the knee, but under no circumstances should the seal be fixed within 2 in. of the knee joint to avoid restriction of movement.



2 Sealing the Envelope

When the head of the envelope is encircling the part of the body on which the envelope is to be sealed, strip the protecting gauze from the adhesive inside the envelope (Fig 1) and take two, or three, pleats in the adhesive, Fig 2. Strip the protecting gauze from the adhesive outside the envelope and press the pleats flat on to the limb. The adhesive on the envelope is provided to enable the circumference of the envelope to be reduced to that of the limb by taking the surplus material into two or more pleats. The adhesive ensures that the fold will, by sticking together, make watertight pleats. So far as possible, the fullness in the envelope (created by making the pleats) should be distributed over the injury. If the injury is on top of the limb, make a pleat on either side and fold towards the top of the envelope. If the injury is extending all round the limb, make three pleats and fold so that the fullness is distributed all round the limb.



Pass a piece of webbing plaster twice round the limb, so that half its width is on the adhesive portion of the envelope and half on the skin, Fig 3

Fig 172.—Instruction diagram for irrigation treatment. (Bunyan Stannard.)

grafting can be undertaken this step being performed as early as possible to prevent scarring and contractures, which

Later the muscles become fibrosed and contractures develop giving the typical appearance of the hand with the fingers flexed at the interphalangeal joints and extended at the metacarpo phalangeal joints (Figs 174 and 175) The fingers straighten when the wrist is flexed which is in contrast to Dupuytren's contracture where the contracture persists



FIG 174 Volkmann's ischaemic contracture

Treatment—*Prophylaxis* is most important All fractures and dislocations around the elbow should be reduced as soon as possible to reduce swelling to a minimum Great care is needed when fixing these injuries in flexion by a collar and cuff and the degree of flexion should be reduced until the pulse of each arm has the same volume When considerable swelling is present, the arm should be suspended from a Balkan beam to aid reduction of the oedema (As Fig 81) Heat should be applied to the rest of the body by a heat cage, thus causing reflex vasodilatation by abolishing spasm of the arteries

If there are signs that the condition is commencing any plaster-cast should be split wide open and the arm suspended from a Balkan beam If the arm has been fixed by a collar and cuff the degree of flexion must be reduced considerably If there is then no improvement within two hours operative relief must be obtained Some surgeons split the deep fascia of the elbow region, thus relieving the tension beneath and allowing the circulation to recover Others believing that arterial spasm is the chief factor expose the brachial artery near the elbow and divide the artery between ligatures and excise the traumatised section of the vessel after injecting the periarterial sympathetic plexus with novocaine These measures abolish the vasospasm due to overaction of the sympathetic nervous system

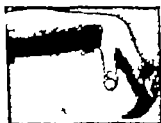


FIG 175 — Volkmann's ischaemic contracture The fingers can only be extended when the wrist is flexed.

whilst for the gastrocnemius the knee is flexed and the ankle plantar flexed and the limb fixed in this position in plaster

VOLKMANN S ISCHAEMIC CONTRACTURE

Volkmann s ischaemic contracture is a contracture of muscles and tendons resulting from the affected muscles being temporarily deprived of their blood supply It is most commonly seen in the flexor muscles of the forearm after elbow injuries but may occur in the anterior tibial group of muscles, and is a most crippling condition very resistant to treatment

The ischaemia of the muscles may be due to venous occlusion at the elbow as a result of swelling and oedema under the deep fascia compressing the veins The muscles become congested and, as further swelling occurs the blood supply becomes cut off completely

Another method by which the ischaemia may occur is by reduction in the arterial blood supply by spasm of the brachial artery resulting from contusion of the sympathetic nerve plexus around the artery (traumatic arterial spasm)

The venous occlusion is often brought about or accentuated by the careless treatment of injuries around the elbow in flexion with the arm flexed too acutely or by treatment of the injuries in unyielding plaster casts without adequate supervision

The early symptoms are pain and tingling or a sensation of pins and needles in the fingers, and if unrelieved, the fingers become numb and anaesthetic The pulse on the affected side is weak or absent Venous congestion causes the hand to be livid, but as ischaemia becomes more marked, the colour gives way to pallor The fingers become flexed at the interphalangeal joints and extended at the meta carpo-phalangeal joints and when this is present, the muscles are permanently damaged It is important that the nurse should recognise the early signs of the impending condition and should summon the surgeon at once In severe cases, nerve paralyses result from pressure of the exudation into the tissues or from ischaemia

brachialis anticus muscle of the arm following injuries fractures, and dislocations of the elbow joint and adjacent bones It is due to tearing of the periosteum of the humerus at the time of injury with displacement of osteoblasts into the muscle and development of the bone from these The mass of bone is often irregular in shape and density, and may or may not connect with the skeleton



Fig 177 —Myositis ossificans. Note the new bone formation anterior to the elbow joint.

The presence of the condition must be suspected when the movements of the joint become increasingly restricted and painful An X ray examination reveals the presence of the ossification in the muscle (Fig 177)

Treatment —The onset of the condition can be prevented to a considerable extent by the prohibition of passive stretching of the elbow joint in any form in an endeavour to increase the range of movement following immobilisation for an injury The movement must be increased by the use of active exercises only

Treatment of the established condition—Conservative measures are first tried the aim being to stretch the contracted muscles until the fingers can be straightened when the wrist is extended The fingers are first splinted in the extended position with the wrist flexed The wrist is then gradually extended by means of special splints (Fig 170)

If conservative measures are insufficient operative treatment is indicated Various operations have been devised for the relief of the contracture The commonest one is Max Page s muscle slide operation where the flexor muscle origin is erased from the medial epicondyle of the humerus

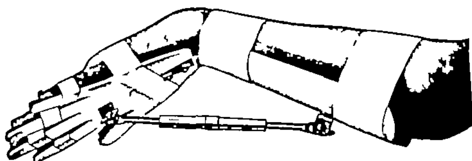


FIG 170—Splint for Volkmann s ischaemic contracture Adjust the splint so as to conform to the angle of flexion of the wrist which is required to permit full extension of the fingers. The splint is then padded with felt. The hand and fingers are bandaged to the splint, each finger being fixed separately Extension of the wrist is then applied gradually by the turnbuckle The splint is removed frequently for massage passive stretching and active exercises.

and the origin allowed to slide down to a point nearer insertion The fingers and hand are immobilised in the overcorrected position for four weeks to allow this to take place. Active exercises and passive stretchings of the muscles are then commenced Other operations consist of multiple tendon lengthening or shortening of the bones of the forearm or excision of the proximal row of carpal bones which shorten the length of the rigid structures of the forearm

TRAUMATIC MYOSITIS OSSIFICANS

Myositis ossificans is the occurrence of ossification in muscle following trauma It occurs most commonly in the

fascia and the adherent skin and immediately apply a full thickness skin graft. The contracted joint capsules play a considerable part in causing relapse of the deformity. Thus with all methods daily passive stretching is essential after operation and a night splint should be worn for some months in order to keep the fingers in the fully corrected position.

AFFECTIONS OF TENDONS

WOUNDS INVOLVING TENDONS

A cut tendon is a serious injury because of the poor results frequently obtained following repair. The tendons of the fingers are most commonly affected, as finger injuries constitute at least 50 per cent. of modern industrial accidents. The results of suture of cut flexor tendons when the tendon sheath is opened are bad, and useful voluntary movement afterwards is exceptionally rare. Suture of extensor tendons, however, produces much better results.

In recent wounds the tendon is sutured only if the wound can be said to be definitely clean, such as occurs following severance with glass or a sharp instrument. With the lacerated wounds which are commonly seen in industrial workers, it is best to leave the tendon unsutured and close the skin wound. When the skin is completely healed and all vestige of infection gone, one can suture the cut tendon using a separate incision. The tendon is sutured with silk or stainless steel wire, as these produce less reaction than catgut, and infection is less likely to occur. After operation the limb is splinted to prevent tension on the suture line. Passive movements are commenced on the tenth day after operation, the splint being removed for these movements and replaced after their performance. Active exercises and occupational therapy are commenced on the eighteenth to twenty-first day after operation.

When the condition develops the joint must be immobilised immediately in order to rest the affected muscle With this, the muscle lesion becomes quiescent and the bone becomes clearly defined on X ray examination. Active movements may then be commenced Operative excision of the bone is only performed some months after the condition has subsided and then only if the bony mass is so large as to mechanically limit movement to a considerable degree. Too early excision will result in recurrence



Fig 178—Dupuytren's contracture Note the taut bands in the palm of the hand.

DUPUYTREN'S CONTRACTURE

Dupuytren's contracture is an affection of the palmar fascia causing flexion of the metacarpo-phalangeal and proximal interphalangeal joints, and extension of the distal interphalangeal joint of the fingers affecting the little and ring fingers most commonly The palmar fascia becomes contracted and nodular and the skin becomes adherent to the contracted parts, with the result that the deformity becomes rigid. (Fig 178) The joint capsules of the fingers then become contracted, and arthritic changes develop in the joints The condition is often familial and bilateral, although one hand is usually affected some time before the other It has to be distinguished from contractures due to burns, sepsis other forms of trauma and congenital contracture. The characteristic deformity in the latter condition is that of hyper extension of the metacarpo-phalangeal joint with flexion of the other joints

Treatment.—Many methods of relieving the contracture have been devised Multiple subcutaneous tenotomy of the taut bands, followed by splinting in the over-corrected position, may give satisfactory results in early cases, but the adhesion of the bands to the skin presents difficulty A more radical procedure is to excise the palmar fascia and to splint the fingers The best procedure is to excise the contracted

loose bodies scraped out and the wound closed Plaster immobilisation is then continued This operation often fails to cure the condition and for these cases and where caseation is present the sheath is excised

SUBCUTANEOUS RUPTURE OF A TENDON

Tendons may rupture or be torn from their insertion by violent muscular contraction or by violent stretching by a forcible movement of its insertion Occasionally the tendon is previously attenuated by friction in its bony groove if the floor of the groove is irregular as after fracture or associated with osteo-arthritis and rupture then occurs with a slight injury Common examples are rupture of the long head of the biceps brachii plantaris tendon extensor pollicis longus tendo-Achilles and ligamentum patellae

The patient experiences sudden pain in the limb following some violent muscle contraction and finds that he cannot use the affected muscle

The condition is treated by suture of the tendon followed by immobilisation so as to relax the affected muscle tendon The immobilisation is maintained for four weeks and active exercises then commenced

MALLET FINGER

Violent extension of the distal phalanx of a finger may cause the insertion of the extensor tendon with a piece of bone attached to be sheared off This causes loss of power of extension of the distal phalanx, and flexion deformity results

The condition is treated by immobilisation of the finger in plaster with the distal phalanx hyper-extended and the middle phalanx flexed This produces relaxation of the distal part extensor tendon and allows the bony fragments to come in contact (Figs 179 and 180) Immobilisation

TENOSYNOVITIS

Tenosynovitis occurs chiefly in the forearm in the abductor pollicis longus and extensor pollicis longus and brevis tendon sheaths In the leg the tendon sheath of the tibialis anterior is usually affected The condition follows excessive use of the affected tendon and is characterised by marked pain in the forearm when the wrist and thumb are moved. Examination reveals some swelling of the tendon sheath associated with tenderness and crepitus on passive movement of the wrist The condition usually subsides with *absolute rest provided by immobilisation of the forearm and hand in a plaster-cast for three weeks* Any septic focus especially gonorrhoeal vesiculitis and prostatitis, is sought for and treated

CHRONIC TENOSYNOVITIS

A chronic form of tenosynovitis may occur due to tuberculosis or syphilis *Syphilitic tenosynovitis* resembles a persistent subacute tenosynovitis and is treated by general antisyphilitic remedies

Tuberculous tenosynovitis is associated with considerable swelling and thickening of the tendon sheath There is usually a serous effusion into the sheath and fibrinous loose bodies are often present, the latter being known as melon seed bodies because of their appearance The flexor tendon sheaths at the wrist are most commonly affected forming diffuse fluctuant swellings in the palm and forearm above and below the wrist joint

Treatment consists of general measures to improve the patient s general condition, in many cases sanatorium treat ment being advisable Local treatment should be conserva tive at first, the hand and forearm being immobilised in a plaster cast for at least six months in order to provide adequate rest to the tendon sheaths If conservative methods fail the sheath may be opened the granulation tissue and

example is dislocation of the peroneal tendons from the groove behind the lateral malleolus, producing pain and swelling and difficulty in walking. If untreated the dislocation tends to recur with increasing frequency and ease.

Initial treatment should aim at resting the tendon until the sheath becomes fixed again in the bony groove. Firm strapping of the region of the bony groove with rest and relief from weight bearing for ten days, will often restore the tendon to normal. *Recurrent cases* need operative measures to anchor the tendon in the groove using part of an adjacent tendon as a sling or by deepening the groove for the tendons. After operation, the limb is immobilised in a walking plaster for four weeks.

NEOPLASMS OF TENDON SHEATHS

Neoplasms of tendon sheaths are rare. They may resemble the giant cell tumours of bones or they may consist of fat or blood vessels. They are treated by excision.

for four weeks is required If the deformity still persists, operative fixation is performed followed by immobilisation in plaster as for the conservative method

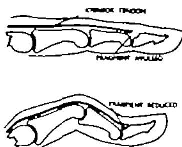


FIG 179 —" Mallet " finger Note reduction when the distal phalanx is hyper-extended and the proximal phalanges are flexed



FIG. 180 —" Mallet " finger plaster applied. More hyper-extension of the distal phalanx is usually required than is shown.

TRIGGER FINGER (STENOSING TENDOVAGINITIS)

Trigger finger is a condition where there is interference with the movement of the finger at one definite position of the finger When a certain degree of flexion is reached active movement is arrested, but passive flexion causes a sudden release of the finger and the active movement can be completed It is due to a constriction of the tendon sheath which may result from irritation caused by over activity of the tendon or from trauma

Relief is obtained by operative division of the constriction under local anaesthesia Active movements of the digit are continued immediately after operation

DISLOCATION OF TENDONS

An uncommon affection of tendons is dislocation of a tendon from its bony groove as a result of trauma. A common

example is dislocation of the peroneal tendons from the groove behind the lateral malleolus producing pain and swelling and difficulty in walking If untreated the dislocation tends to recur with increasing frequency and ease

Initial treatment should aim at resting the tendon until the sheath becomes fixed again in the bony groove Firm strapping of the region of the bony groove with rest and relief from weight bearing for ten days will often restore the tendon to normal *Recurrent cases* need operative measures to anchor the tendon in the groove using part of an adjacent tendon as a sling or by deepening the groove for the tendons After operation the limb is immobilised in a walking plaster for four weeks

NEOPLASMS OF TENDON SHEATHS

Neoplasms of tendon sheaths are rare They may resemble the giant cell tumours of bones, or they may consist of fat or blood vessels They are treated by excision

CHAPTER IX

CONGENITAL DEFORMITIES

CONGENITAL DISLOCATION OF THE HIP

CONGENITAL dislocation of the hip consists of a partial or complete displacement of the head of the femur from the acetabulum, and is the commonest of all congenital dislocations It is often bilateral and occurs more commonly in girls It is due to mal development of the acetabulum The acetabulum is more shallow than normal, and its posterior and upper lip is deficient At first the femoral head is normal but later becomes small and atrophic, and is associated with some degree of coxa valga The capsule of the hip joint is thickened and elongated and usually has an hour glass constriction The abductor and adductor muscles are shortened and are a source of difficulty during reduction

Symptoms and signs—The child may be brought for opinion during infancy because one limb appears longer or better developed than the other If the child has walked a limp or waddling lurching gait will be noticed. On examination, the patient will be seen to have a prominent lordosis and scoliosis and a prominent great trochanter on the affected side If the dislocation is bilateral there is evident widening of the perineum and the legs appear to be short for the size of the body (Fig 181) Measurements of the limb reveal shortening on the affected side the great trochanter lying above a line drawn from the ischial tuber osity to the anterior superior spine (Nelaton s line) The movements of the hip are usually painless and are limited only in abduction and external rotation Flexion of both hips and knees to approximately 40 will show the affected knee to be lower than the sound limb X ray examination will reveal the presence of the dislocation and the deformed acetabulum but the fact that the head of the femur is

cartilaginous in infants provides some difficulty in diagnosis (Fig 182)

Treatment —The aim of treatment is to reduce the dislocation early when the tissues are pliable and before irreparable deformity has developed following walking If the dislocation is reduced early there is a good chance that



(a) (b)

Fig 181

(a) Old relapsed bilateral congenital dislocation of the hips. Note the prominence of the trochanteric region the wide perineum and exaggerated lordosis.

(b) Lateral view of the same patient, showing increased lordosis.

the acetabulum will develop along more normal lines and provide a stable socket for the head of the femur When the reduction has been accomplished it must be maintained and this is usually obtained by immobilisation in plaster *For infants* who have not borne weight on the legs, immobilisation of the hips in abduction may be obtained on



Fig 182.—X ray photograph of congenital dislocation of the hip.



Fig. 182a.—X ray photograph of congenital dislocation of the hip.

a Putti mattress (Fig 183) which often allows reduction to occur and the acetabulum to develop and form a stable joint

Cases seen under four years of age are reduced by Lorenz's manipulation under general anaesthesia adductor tenotomy sometimes being necessary before this can be accomplished If the reduction is successful, the hamstring muscles are taut and cause the knee to be flexed to 90° X ray examination is made to verify the reduction A plaster cast is then applied with the legs fully abducted and externally rotated and flexed to 90° enclosing the pelvis and both legs to the knees Some surgeons continue the plaster below the knee The author prefers not to enclose the knee as hip rotation can then occur It is important that the plaster be kept dry, otherwise cracking will occur and allow re-dislocation To avoid this, the child should be placed on a frame with the legs supported to prevent severe rotation strain at the hips A watch should be kept for pressure sores on the medial and posterior aspects of the knees (Figs 184 and 185) Older children



Fig 183.—Putti mattress used for treatment during infancy

are encouraged to bear weight on the limbs and to use the legs by sitting astride a seat on wheels, such as a kiddie-car' Passive and active knee exercises are performed the taut hamstrings receiving passive stretching The limbs are maintained in this position for 7–9 months and then the cast is removed and the stability of the reduction tested If the reduction is stable the child is left without the plaster-cast and allowed to bear weight. Some surgeons prefer to gradually reduce the degree of abduction and external rotation every three months, finally removing the

plaster at the ninth month If the reduction is not stable further immobilisation is necessary In some cases an osteo



FIG 184 —Bilateral congenital dislocation of the hip joints after reduction and application of the plaster-cast.

tomy may be necessary to correct extreme anteversion of the femoral neck

If the child does not come under treatment until it is

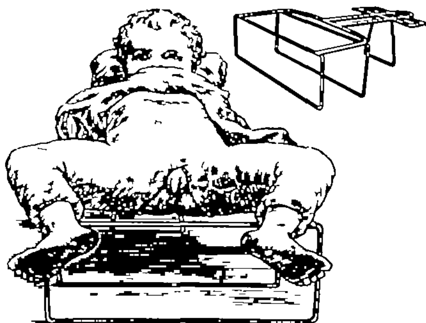


FIG 185 —A nursing frame is invaluable for preventing soiling and and crumbling of the plaster

over four or five years of age the tissues are too contracted and rigid to allow manipulative reduction and open operative

reduction is required The same operation will be necessary for younger cases when manipulation has failed a constriction of the elongated capsule or adhesion of the capsule to the acetabulum being the chief causes of this After reduction the hip is immobilised as after the closed reduction and similar after treatment given

If the acetabulum does not develop sufficiently to allow the reduction to be stable a shelf of bone is made to deepen the socket bone being levered down from the ilium and supported by a bone graft (Fig 180) After the operation the hip and pelvis are im

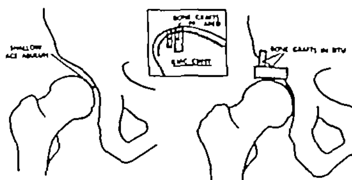


Fig 180 —" Shelf " operation for congenital dislocation of the hip using bone grafts from the ilium The graft provided a roof to the acetabulum and so improves stability

mobilised in a single plaster hip spica for three months After removal of the plaster hip exercises and re-education of walking are commenced

Eighty per cent of patients suffering from a congenital dislocation of the hip can be cured and the majority of these will need conservative measures only

CLUB-FOOT (CONGENITAL TALIPES)

Club-foot includes talipes equino-varus and talipes calcaneo-valgus, and is often associated with other congenital defects, such as spina bifida club-hand and hydrocephalus

CONGENITAL TALIPES EQUINO VARUS

Congenital talipes equino-varus is a deformity which has four elements, and of these, three are invariably present



Fig 187 —Manipulation of the foot for talipes equino-varus.

(*a*) plantar flexion of the ankle and forefoot
(*b*) adduction of the forefoot
(*c*) inversion of the foot
(*d*) medial rotation of the tibia

The latter is not always present. Two main theories of causation are held at present Denis Browne s theory postulates that excessive intra uterine pressure is the cause of the deformity Brockman however maintains that there is an aplasia of the talo-navicular joint similar to that in congenital dislocation of the hip followed by contracture of the muscles and liga ments on the medial side of the foot. In neglected cases there is shortening of the soft tissues on the medial and plantar aspects of the foot, and deformity of the astragalus and calcaneus Callosities develop on the outer side of the foot because of the irritation due to body weight being borne there



Fig 188 —Denis Browne talipes splint with felts applied. The right footpiece has been wedged on the outer side with felt strips.

Treatment.—Diagnosis should be made at birth and treatment com menced immediately Manual cor rection of all the elements of the deformity should be performed daily for the first fourteen days (Fig 187) the foot being forced into extreme dorsi flexion, abduction, and eversion The foot is then fixed on a Denis Browne talipes splint. (Fig 188) The foot piece is wedged laterally with felt (Fig 189) and the foot strapped to it with zinc oxide strapping or elasto-

plast protected by felt or lint (Fig 190) The side piece is then strapped to the outer side of the leg thereby correcting the inversion The feet are then fixed to the cross bar of the splint with each foot externally rotated at an angle of 90° with the sagittal plane when both feet are affected and at an angle of 20° and 90 if only one foot is affected (Fig 191) The advantage of the splint is that muscle tone is maintained and correction obtained by the child kicking in the splints Removal of the splints is required weekly for further manipulation After nine months treatment special open toed boots are fitted to the splints (Fig 192) and, after twelve months the splints can usually be dispensed with provided the



Fig 189 —Application of Denis Brown splints. The right foot has been fixed to the footplate which is shown attached to the crossbar In practice one splint is applied to each leg before fixing into the crossbar Note the felt wedging on the lateral aspect of the splint and note the position of the vertical part of the splint. When the latter is fixed to the leg the foot is pulled into eversion



Fig 190 —Denis Browne splint applied for bilateral talipes equino-varus. The vertical portions of the splints have been strapped to the legs bringing the feet into eversion The crossbar is then applied and the feet deviated 180 to each other so correcting the varus deformity

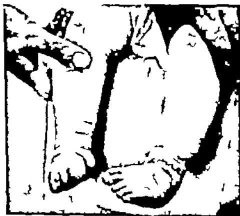


Fig 191 —Bilateral talipes equino-varus

correction is maintained A night splint is worn for a further 9–12 months (Fig 198) to aid maintenance of

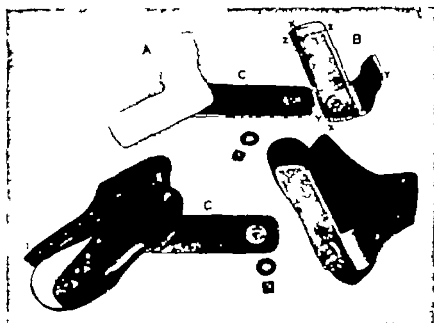


FIG 192 —Denis Browne open toe boots for later stages of treatment of talipes.

correction Repeated manipulation and immobilisation in plaster-casts is a method favoured by some surgeons In this procedure, the plaster-cast should come above the knee, with the knee flexed to maintain full correction

In late untreated cases manipulation with a Thomas wrench or Denis Browne nutcracker vice is required followed by treatment with plaster-casts or Denis Browne splints, as for earlier cases Persistent cases may need an operation to divide the contracted tissues on the medial aspect of the foot and to divide the contracted capsule of the talo-navicular joint. (Brockman s operation)

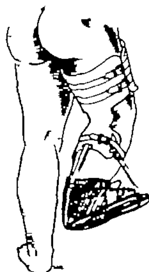


FIG 193 —Denis Browne night splint for talipes equino-varus.

Advanced and relapsed cases need operations on the bones of the foot to correct the deformity as soft tissue operations will not give sufficient correction or allow any correction obtained to be maintained Wedges of bone are removed so as to produce an arthrodesis of the mid tarsal and sub astragaloid joints and correction of the deformity (Fig 104) The operation is not performed before the age of twelve because of the cartilaginous nature of the tarsal bones before that time After operation the foot is immobilised in a well padded plaster in the corrected position for 14 days This plaster is then changed the sutures removed and a new cast applied using no padding It is retained for 3 months



(*a*) (*b*)

FIG 104 (*a*) and (*b*) —Result of triple arthrodesis for advanced neglected talipes equino-varus.

All cases need prolonged supervision if relapse is to be prevented

TALIPES CALCANEO VALGUS

Talipes calcaneo valgus is a deformity where the foot is fixed in eversion dorsi flexion and abduction Treatment consists of repeated stretchings by the mother and masseuse bringing the foot into plantar flexion adduction and inversion *i e* equino-varus The mother is instructed to hold the feet in this position whilst the child is feeding and to perform the manipulation thrice daily These measures are often sufficient for mild cases Severe cases need repeated manipulations and immobilisation in plaster in full correction When the correction can be maintained *manipulation* is stopped and night splints only are worn

correction is maintained A night splint is worn for a further 9–12 months (Fig 193) to aid maintenance of

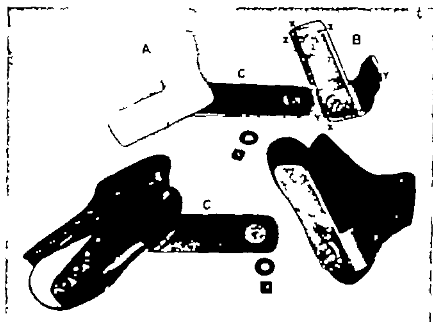


Fig 192 —Denis Browne open toe boots for later stages of treatment of talipes.



Fig 193 —Denis Browne night splint for talipes equino-varus.

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(a) (b)

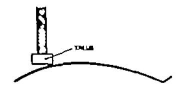
FIG 104 (a) and (b) —Result of triple arthrodesis for advanced neglected talipes equino-varus.

All cases need prolonged supervision if relapse is to be prevented

TALIPES CALCANEO VALGUS

Talipes calcaneo-valgus is a deformity where the foot is fixed in eversion dorsi flexion and abduction. Treatment consists of repeated stretchings by the mother and masseuse bringing the foot into plantar flexion adduction and inversion i.e. equino varus. The mother is instructed to hold the feet in this position whilst the child is feeding and to perform the manipulation thrice daily. These measures are often sufficient for mild cases. Severe cases need repeated manipulations and immobilisation in plaster in full correction. When the correction can be maintained manipulation is stopped and night splints only are worn.

For old untreated and relapsed cases operative treatment is necessary This may consist of a form of triple arthrodesis or Whitman's astragalectomy (talectomy) In the latter operation the astragalus (talus) is excised and the tibia and fibula displaced forwards to fit into sockets cut in the cuboid and navicular so that the body weight is borne over the centre of the foot. (Fig 195) After operation the leg is immobilised in plaster for three months, and then mobilisation and walking exercises commenced



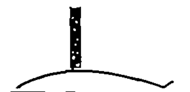


Fig 195—Diagrammatic representation of astragalectomy After excision of the bone the foot is pushed backward so that the tibia and line of weight bearing lies over the scaphoid cuboid and bone.

CONGENITAL HIGH SCAPULA (SPRENGEL'S SHOULDER)

Congenital high scapula consists of a permanent elevation of the shoulder and is often associated with other congenital deformities, especially errors of segmentation of the vertebral column, *e g* the presence of a cervical rib or absence of vertebrae. The scapula is abnormal in shape, being broader and more curved than usual It is often attached to the vertebral column by bony or fibrous bands and many muscles of the shoulder girdle are absent. Clinically there is absence of full abduction and elevation of the arm because the scapula does not rotate

Treatment.—Operative treatment is limited to dividing bony or fibrous bands in order to improve shoulder movement. Any attempt to place the scapula in the new position is usually followed by relapse and the brachial plexus may be stretched and damaged when the scapula is lowered

CONGENITAL SHORT NECK (BREVICOLLIS)

In congenital short neck there is reduction in the number of cervical vertebrae Many of the vertebrae present are

abnormal synostosis and non fusion of the spinous processes being common There is often torticollis and neck movement is restricted The condition is not amenable to any treatment but should be differentiated from torticollis and Pott s disease, which respond to treatment

CERVICAL RIB

The ribs are developed from the costal processes of the vertebrae the first rib normally arising in association with the first dorsal vertebra Occasionally the costal process of the seventh cervical vertebra enlarges to form an accessory rib forming a cervical rib The enlargement may consist of a complete rib or an almost complete rib the bone being continued to the first rib by a fibrous band Another variety is where the rib projects just beyond the transverse process The first dorsal and eighth cervical nerves and subclavian artery are stretched over the process Not all cervical ribs cause symptoms, and when symptoms are present they do not develop until the second decade A debilitating illness is often a precursor of the onset of symptoms muscle weakness allowing the shoulders to droop and so increase the stretching of the brachial plexus and subclavian artery Friction of the artery and nerves over the rib causes a friction neuritis of the sympathetic and peripheral nerves Thus vasospasm follows causing pain numbness and tingling which radiate down the arm, and reduction in the volume of the pulse on the affected side. The pressure on the lower cord of the brachial plexus leads to wasting and weakness of the lumbricals and interossei and muscles of the hypothenar eminence, causing a claw hand An X ray examination will reveal the presence of a rib but the severity of the symptoms does not correspond with the size of the rib

Treatment.—Treatment is only required in the presence of symptoms In early cases with mild symptoms physiotherapy should be given to the shoulder muscles to remove any drooping of the shoulders With persistent symptoms, operation is undertaken The condition is relieved by division

of the scalenus anterior tendon which holds the nerves and vessels firmly against the rib occasionally excision of the rib is necessary

TORTICOLLIS

Torticollis is a deformity characterised by lateral inclination of the head towards the shoulder with torsion of



FIG 196 —Congenital torticollis

the neck together with deviation and hemiatrophy of the face The occiput deviates towards the shoulder (Fig 196) It is due to

(a) developmental defects in the sterno-mastoid muscle, or shortening following a birth injury to the muscle This is the common congenital type
(b) Brevicollis is often associated with a torticollis, the rotation being due to vertebral defects
(c) An acute form is found in infections of the neck It disappears when the cause is eliminated

(d) A paralytic form occurs in injury of the accessory nerves

(e) A spasmodic type which occurs chiefly in adults is a spasmodic tic, and is usually psychogenic in origin

CONGENITAL TORTICOLLIS

Congenital torticollis is often unnoticed by the parent until the child is 7–8 years of age but the defect has been present since birth It is noticed at this period of life because rapid growth is occurring and the defect becomes accentuated It is thought that a birth injury causes a haematoma and some ischaemia in the sterno-mastoid muscle This organises and fibroses like a Volkmann's ischaemic contracture

The head is always rotated from the affected side and laterally deviated towards it The vessels and cervical fascia and the sterno-mastoid of the affected side are contracted and taut The affected side of the face is smaller than the opposite side and the skull seems to be twisted so that the frontal eminence on the affected side is flattened and the occipital region is more prominent. This is known as scoliosis capitis There is a compensatory dorsal scoliosis

Treatment.—In early very mild cases manipulation and exercises will give a satisfactory correction but after the age of 2–3 years, operation is indicated Subcutaneous tenotomy or open tenotomy of the sterno-mastoid can be performed Each method gives good results The author prefers the open method as this allows division of tight bands of fascia in addition to the sterno-mastoid which is impossible with the closed method Post operative treatment consists in immobilising the head and neck with sandbags or in a plaster cast in the over corrected position until the sutures are removed after which active and passive exercises are practised and deep massage given over the tenotomised area Head suspension ten minutes daily is a valuable addition to treatment Remedial exercises are necessary to aid correction of the scoliosis and orthoptic treatment may be needed as the eye muscles have become accustomed to maintaining the

visual axes parallel when the head was deviated, and the normal muscle balance of the eyes will have been altered

CONGENITAL ABSENCE OF THE RADIUS

This deformity though rare, is the commonest cause of club-hand It is often associated with other congenital deformities, such as cleft palate, hare lip and congenital

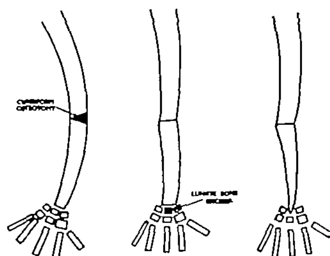


FIG. 107 —Principles of treatment of congenital absence of the radius. The bowing of the ulna is corrected by osteotomy The lower end of the ulna is sharpened and inserted into the socket left after excision of the semilunar

club-foot. The whole of the radius is usually absent. The ulna is thick and curved, with its *concave aspect towards* the lateral side of the arm The thumb is often absent, together with the carpal bones and extensor muscles on the radial side of the limb Flexion and deviation of the wrists to the radial side is usually present.

Treatment is operative Many operations have been devised to correct the defect The principle in all operations is to correct the bowing of the ulna and to fix the ulna to the carpus, either by inserting it into a gap in the carpus or to prevent radial deviation at the wrist by a graft fixed to the ulna and the *radial aspect of the* carpus *(Fig 107)*

SYNDACTYLISM (WEBBED FINGERS OR TOES)

Syndactylism is a deformity where two or more fingers or toes are fixed together The connection between the fingers or toes varies from a thin web of skin to thick bony fusion

Treatment is by operation This should not be performed before the patient is five years of age unless deformity is increasing Before this age the parts are too small to give a satisfactory result to operation At operation it is important to reconstruct the normal dorsal inclination of the web This is done by using skin turned up from the dorsum or by using free skin grafts After operation, exercises and occupational therapy are necessary to educate the hands.

CHAPTER X

AFFECTIONS OF THE EPIPHYSES

I EPIPHYSITIS (or OSTEOCHONDRITIS)

OSTEOCHONDRITIS is a non inflammatory affection of an epiphysis where derangement of the normal growth of the bone occurs It develops in childhood, and no definite cause can be ascribed to it. There is usually a history of slight trauma and in some cases, there has been some recent evidence of infection in another region of the body Each epiphysis has a definite age period when it is prone to be affected

The *symptoms* are very similar whatever the site of the affection The onset is gradual, with vague pain in the affected joint There is limitation of movement on examination of the joint, and a limp can be detected when the hip or knee are affected There may be some swelling over the affected joint An X ray examination reveals a fragmentation of the epiphyseal line while the epiphysis itself is denser than normal fragmented flattened and irregular Healing often occurs spontaneously without treatment, leaving some permanent deformity of the epiphysis *Treatment* aims at relieving strain on the epiphysis and preventing or correcting deformity until spontaneous healing occurs

(a) OSTEOCHONDRITIS OF THE HIP (PERTHES DISEASE)

Perthes disease usually commences when the child is about six or seven years of age, and affects the head of the femur and, on rare occasions, the acetabulum The history is one of gradual onset of pain in the hip this usually being a vague ache which may be referred to the knee It is accompanied by a feeling of tiredness and a limp When examined the hip is found to be held in slight flexion and

adduction due to muscle spasm and there is *restriction of* abduction and external rotation movements The other joint movements are not affected thus serving to distinguish the condition from tuberculosis *of the hip where all move*ments are restricted Spontaneous healing occurs in $1\frac{1}{2}$–2 years but there is some residual restriction of movement (Fig 108)

Treatment consists of confinement to bed with immobilisa-



FIG. 108 —X ray photograph of Perthes disease of the hip showing fragmentation and condensation of the epiphysis of the head of the femur

tion and traction applied to the hip in a position of abduction Authorities differ on the period of immobilisation and traction necessary varying from 1–12 months There appears to be good evidence that prolonged traction does produce better results When there is X ray evidence that the lesion is healing as seen by reduction in density and fusion of the fragmented epiphysis, the child may be got up with a walking caliper thus allowing non weight bearing movements This is worn until the femoral head is completely reconstituted

(b) OSTEOCHONDRITIS OF THE UPPER TIBIAL EPIPHYSIS (OSGOOD SCHLATTER'S DISEASE)

The upper tibial epiphysis may be affected between the ages of 13 and 15 The patient complains of pain on passive flexion and active extension of the knee joint, situated over the tibial tubercle *Treatment* aims at preventing strain on the epiphysis caused by excessive flexion of the knee until healing is complete This is obtained by applying a plaster



FIG 109 —X ray photograph of Kohler's disease of the tarsal scaphoid.

cast from the groin to 2 in above the malleoli at the ankle, and allowing the patient to walk Eight or ten weeks immobilisation is usually sufficient.

(c) OSTEOCHONDRITIS OF THE TARSAL SCAPHOID (KÖHLER'S DISEASE)

The tarsal scaphoid may become the site of osteochondritis, and usually occurs when the child is 3–6 years of age. The chief complaints are aching a burning sensation, and tiredness of the foot Spasmodic flat foot may be

present X ray examination reveals narrowing of the bone together with fragmentation and increase in density (Fig 109)

Treatment consists of immobilisation of the foot in plaster for a minimum period of three months After removal of the plaster the child is allowed to walk in shoes which have Thomas heels (*vide infra*) The latter afford support to the scaphoid

(*d*) OSTEOCHONDRITIS OF THE OS CALCIS (SEVER S DISEASE)

The epiphysis on the posterior aspect of the os calcis may be the site of osteochondritis the disease appearing between the ages of 8 and 11 The chief complaint is pain and tenderness of the heel It is treated by immobilisation of the leg in a plaster cast extending from the toes to the mid thigh with the foot in slight equinus Weight bearing is not allowed After three months the cast is removed sponge rubber pads fixed in the heels of the shoes and weight bearing commenced

(*e*) OSTEOCHONDRITIS OF THE SPINE (SCHEUERMANN S DISEASE)

Vertebral epiphysitis affects adolescents producing a gradually increasing kyphosis and vague backache The patient should be immobilised on a Whitman frame or plaster bed with the spine hyper extended so as to correct the deformity Traction may be necessary if muscle spasm is severe After 3–4 months the patient may be allowed up and a spinal brace fitted, and exercises given to develop the spinal muscles The brace may be discarded after wearing for 12–18 months

II COXA VARA

Normally the femoral neck makes an angle of 120° with the shaft of the femur If this angle is reduced coxa

vara is said to be present (Fig 200) It may be caused by rickets fracture tuberculosis or osteomyelitis affecting the head or neck of the femur, or Perthes disease, but it is more commonly due to slipping of the epiphysis of the head of the femur The epiphysis separates from the neck of the femur and rotates so as to face backwards and downwards. If not treated the epiphysis unites in this position, causing coxa vara The lesion affects boys more than girls, and occurs most commonly between the ages of 10 and 12 A history of trauma may be elicited, but often this is completely absent.

The deformity causes a limp and restriction of abduction, internal rotation and flexion of the hip-joint. Adaptive shortening of the abductors and adductors follows, thus

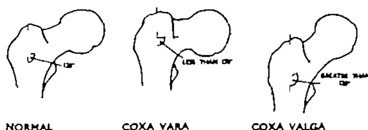


Fig 200 —Defects of the femoral neck-shaft angle.

increasing stiffness and limitation of movement Vague pain is experienced in the hip and thigh while measurements of the legs reveal the presence of shortening in the affected leg due to the decreased angle between the femoral shaft and neck Scoliosis and compensatory genu valgum and flat foot are common accompaniments of the deformity

Treatment—*With early cases of slipped epiphysis* reduction can usually be obtained by traction on a Jones abduction frame with the legs in the neutral position between abduction and adduction both limbs being bandaged to the frame The affected limb is then gradually abducted Repeated X ray examination is used to control the degree of reduction, and when full reduction has been obtained the traction is maintained for a further month A walking caliper is then fitted and worn for twelve months Some surgeons fix the epiphysis with a Smith Petersen nail after reduction

If the epiphyseal separation has healed in the displaced position and for other types of coxa vara a sub trochanteric osteotomy is performed to correct the deformity and the shortening

Old neglected cases develop osteo arthritis of the hip joint and this must be treated

CHAPTER XI

PERIPHERAL VASCULAR LESIONS

PAIN in the extremities may be due to peripheral vascular disease and the disordered locomotor function which results may cause the patient to seek the advice of an orthopaedic surgeon.

OBLITERATIVE VASCULAR LESIONS

The obliterative type of vascular affections which one encounters most commonly are Buerger's disease (thrombo-angiitis obliterans) and arteriosclerosis. They affect the lower limbs more commonly than the upper and are characterised by the appearance of pain during moderate exercise, which is relieved by rest. The pain is due to deficiency of the blood supply to the muscles. The limb may be oedematous and discoloured when dependent, and subject to recurrent attacks of phlebitis. Emboli may lodge in the narrowed blood vessels resulting in pain, anaesthesia, and pallor below the level of the vascular block. Gangrene of the peripheral parts of the limb may supervene because of the defective blood supply if the collateral circulation does not dilate sufficiently to maintain it. Buerger's disease occurs in young subjects and is slowly progressive, the lesions often culminating in gangrene. There is often an element of vasospasm present, and if this can be alleviated, the danger of gangrene may be averted. Arteriosclerosis occurs in older *subjects and is associated with very little vasospasm.*

Treatment.—Firstly one uses measures designed to improve the general and local circulation. This may be obtained by injections of T.A.B. vaccine or colloidal sulphur. A more prolonged and repeated effect may be obtained by means of a passive vascular exerciser which produces vaso-dilatation by means of alternately compressing and exposing the limb to a vacuum. Buerger's exercises, *i.e.* alternately

raising the limb until pallor appears and then allowing it to be dependent until it becomes congested followed by resting the limb in a horizontal position for five minutes are practised daily Intravenous infusions of plasma or serum have recently been shown to have a beneficial effect

The patient is instructed in the proper care of his feet in order to prevent abrasions, cuts, and septic callosities and corns He should wash the feet daily apply surgical spirit and then lanoline to avoid scaling Warm woollen socks should be worn which should be changed daily and bed socks worn at night Good fitting shoes are essential in order to avoid abrasions and callosities

If there is some vasospasm present, the surgeon may attempt to remove it by performing a sympathetic ganglion ectomy thus removing the vasoconstrictor influence of the autonomic nervous system which improves the collateral blood supply A similar effect can be obtained by destroying the ganglia by injecting them with 90 per cent alcohol Amputation is necessary when gangrene has supervened

THE VASOSPASTIC LESIONS

The vasospastic type of peripheral vascular disease is exemplified by Raynaud's disease This condition is characterised by the appearance of paroxysms of vasospasm whereby the extremities of the affected limbs become first pallid then cyanosed and then red the latter stage being accompanied by extreme pain The paroxysms last for a varying period of a few minutes to a few hours Gangrene is very likely to follow frequent and prolonged attacks.

The condition may respond to sympathetic ganglion ectomy which removes the element of vasoconstriction

CHAPTER XII

THE ORTHOPAEDIC SURGERY OF PARALYSIS

ANTERIOR POLIOMYELITIS

ANTERIOR poliomyelitis is the result of a general systemic infection with an organism belonging to the group of filtrable viruses the brunt of the infection being borne by the central nervous system. The organism enters the nasopharynx, being carried to man by flies, dust, and human droplet infection. The disease is commoner in the late summer, and often assumes epidemic proportions Children between the ages of 2 and 4 are most commonly affected by the malady but adults are not immune

The infection causes haemorrhage and oedema around the anterior horn cells in the regions of the spinal cord affected, destroying the cells and leading to flaccid paralysis of muscles supplied by these cells Pyrexia, pains in the limbs neck rigidity headache, and gastro-intestinal symptoms are common systemic manifestations of the severer forms of the disease. Milder forms are more common in this country the usual history in such cases being the sudden onset of paralysis of one or more muscle groups in an apparently healthy child or following a catarrhal infection described by the parents as influenza

The paralysis may be fairly widespread at first, due to oedema, and is maximal about the second day of the disease. Recovery from the paralysis occurs to a considerable extent with subsidence of the oedema, leaving partial paralysis or weakness of groups of muscles Bladder paralysis may occur but usually recovers Paralysis of the diaphragm and intercostal muscles needs special treatment in some form of artificial respirator such as an iron lung in order to maintain respiration and life The affected muscles are tender to pressure in the early stages, while atrophy begins within the first week. These changes are associated with loss of the deep reflexes in the affected muscles and the

presence of the reaction of degeneration The latter phenomena comprises absence of contraction when the muscle is stimulated by a faradic or intermittent current a sluggish reaction to galvanic or continuous current stimulation and a reversal of the polar formula As the posterior horn cells of the spinal cord are not affected by the infection anaesthesia is never present

Despite the absence of sensory lesions trophic changes appear later the commonest type being chilblains and blueness of the limbs Retardation of growth of the limb is a frequent accompaniment of poliomyelitis and is probably a trophic change

TREATMENT

Treatment of the general infection is usually undertaken in an infectious diseases hospital and entails administration of prepared immune serum and general measures as for the treatment of any acute fever

Orthopaedic treatment aims at

1 Muscle rest during the acute stage it is important that this phase of orthopaedic treatment should be commenced early before the muscle wasting begins *i.e* in the first week Hence the necessity for close and early co-operation between physician and orthopaedic surgeon at the commencement of the treatment
2 Prevention of deformity muscle stretching and fatigue during the acute and convalescent stage
3 When the spontaneous muscle recovery ceases and this may proceed for a period of two years muscle training and re-education should be commenced
4 Mechanical and surgical treatment may be necessary to prevent and correct any residual deformities to reinforce weak muscles or stabilise flail or unstable joints

During the acute stage the patient should lie on a plaster bed or Whitman frame All paralysed muscles should be splinted so as to prevent overstretching by gravity and by

the overaction of the antagonistic muscles Local heat, *i.e.* by radiant heat or hot packs, is given to relieve pain and tenderness (Fig 201)

During the convalescent stage—This stage commences after subsidence of acute symptoms and tenderness of the muscles and lasts until spontaneous recovery ceases and the paralysis is stationary This stage lasts approximately two years Treatment, therefore, is directed to aid spontaneous recovery and to prevent the onset of deformity The latter entails prevention of contractures, correction of disproportion of muscle balance and defective habit posture and elimination of the effect of gravity

The patient is better treated in the recumbent position

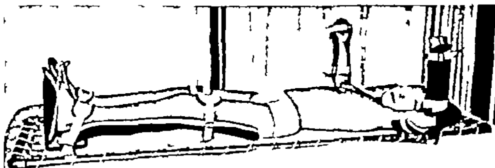


Fig 201—Immobilisation for extensive paralysis due to acute anterior poliomyelitis.

with splinting of the affected muscles in order to prevent shortening or overstretching Towards the end of the convalescent period the patient may be allowed up with some supporting apparatus applied These take the form of abduction and cock up splints for the upper extremity walking calipers for paralysis above the knee side irons with drop foot stops for anterior tibial paralysis and raised heel and strengthened boot tongue for calf paralysis A back brace should be used in abdominal and spinal muscle paralyses (Figs 202 and 203)

Massage is of value in restoring the nutrition of the affected muscles, whilst local heat, hydrotherapy and galvanism aid recovery

Muscle re-education and non weight bearing exercises

should play a prominent part in the treatment during the convalescent period and swimming and under water exercises form an important part of this



FIG 202 Anterior poliomyelitis affecting the right leg causing paralytic eversion, wasting and shortening of the leg The latter has been compensated for by abduction of the hip and tilting of the pelvis to the right side

During the residual stage – During this stage mechanical and surgical measures are undertaken

(i) to correct deformity
(ii) to re-establish muscle power
(iii) to stabilise flail or relaxed joints in order to restore the function of the limb

Correction of deformity —If the deformities are of recent origin conservative measures such as weight traction wedging plasters manipulations and plaster immobilisation will often suffice In older cases, contractures and deformities may be corrected by tenotomies, fasciotomies and tendon lengthening and in some cases osteotomies



FIG 203 —The patient is fitted with a double short leg iron with drop-foot and T-strap to prevent foot drop and eversion so preventing stretching of the weak muscles.

Careful note of the possible results of these operations on the limb as a whole and on the spine is taken before operation so as to prevent increasing instability *e g* an equinus deformity of the foot associated with a weak quadriceps gives a stable limb as the contracted calf muscles lock the knee in extension when weight is borne If the taut muscles are divided the knee becomes unstable

Re establishment of muscle power by tendon transference The aim is to replace the paralysed muscle by a normal one which can reproduce its action These operations are usually used as counterparts to stabilisation operations

Any deformity which is present is corrected first Tendons are selected which have similar power and physiological action to the paralysed muscle At operation the tendon is made to pass to its new insertion by a subcutaneous route, or via a tendon sheath and the insertion made into bone. After operation the limb is immobilised in plaster for 4–6 weeks until the new insertion is firm After removal of the plaster muscle re-education is commenced

The operation of tendon transplantation is used chiefly for paralytic talipes varus, where the tibialis anterior is used to replace the peronei for quadriceps paralysis where the sartorius and tensor fascia lata are transplanted into the patella and for paralysis of the extensors of the wrist and

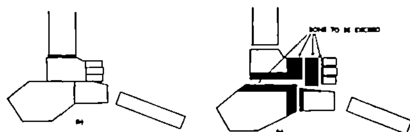


FIG 204 —Naughton Dunn triple arthrodesis (a) showing amount of bone excised and joints arthrodesed, (b) the completed arthrodesis with backward displacement of the foot

fingers using the flexors carpi radialis and ulnaris and palmaris longus

Stabilisation operations consist of arthrodeses bone block operations and the fashioning of fascial slings to restrict abnormal movement in flail joints The arthrodesing operations are delayed until the patient is 10–12 years of age in order to avoid epiphyseal damage and in the foot, to allow sufficient ossification of the tarsal bones to be present for satisfactory bony union to take place.

The arthrodesis operation most commonly performed for foot paralysis is that described by Naughton Dunn For this operation wedges of bone are removed from the sub-astragaloid and mid tarsal joints through a lateral incision in the foot. (Fig 204) The neck of the astragalus is shortened and the head and the scaphoid excised and the foot slid backwards so that the foot balances under the tibia The

foot and ankle are immobilised in a well padded plaster. After operation the limb is elevated to correct swelling and bleeding. The plaster is changed after fourteen days and the foot moulded in good position. This cast is then removed after three months and re-education commenced.

In the upper limb deltoid paralysis is the commonest form of residual defect. Arthrodesis of the shoulder is usually undertaken to correct this, the scapular muscles then being responsible for abduction of the shoulder. The operation consists of fixing the humerus to the scapula by fracturing the acromion and clavicle and inserting the raw surfaces under a hinged bone flap raised from the greater tuberosity or by bridging the space between the axillary border of the scapula and the humerus by a tibial bone graft. The shoulder is fixed at 60° abduction, 20° flexion and 15° external rotation by means of a shoulder spica plaster and immobilisation maintained for three months. Muscle re-education is commenced after removal of the plaster.

Leg lengthening or shortening operations are sometimes undertaken for disturbance of growth of a limb when shortening of 2-3 in. is present.

THE TREATMENT OF ANTERIOR POLIOMYELITIS BY SISTER KENNY'S METHODS

The orthodox treatment of anterior poliomyelitis given above is based upon the theory that the pain in the limb is of central origin and that rest and immobilisation will allow recovery of the affected muscles.

Sister Kenny maintains that the pain is almost entirely vascular in origin and is due to venous engorgement and spasm with consequent ischaemia of the paralysed muscles. The vascular stasis is demonstrated by the coldness and cyanosis of the skin.

Immobilisation of the paralysed limbs will increase the stasis and ischaemic contracture of the muscles follows. She states that the stage of irritation is purely an artefact which can be abolished within two or three days by frequent passive movements and hydrotherapy. Associated with the

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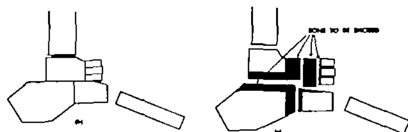


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destruction of nerve cells in the motor area of the brain usually as a result of birth injury or syphilis Only very rarely does it follow an acute fever The destruction of the cells or the nerve pathway to the anterior horn cells constitutes an upper motor neurone lesion A lower motor neurone lesion is an affection of the anterior horn cell and its axon

The muscles of the affected limb are spastic and hypertonic and the deep reflexes are exaggerated There is no wasting of the muscles and the reaction of degeneration is not present these findings being the exact opposite to those in a lower motor neurone lesion Walking is delayed and when developed is inco-ordinated The child stands in a characteristic attitude with the elbow flexed the forearm pronated the wrist flexed and the thumb adducted The leg is adducted flexed and internally rotated the knee is flexed and the ankle is held in equino varus If both legs are affected a scissors gait develops The exaggerated tone is found in the flexor muscles as a result of release of inhibition of the lower motor centres of the brain following destruction of the pyramidal pathway Like poliomyelitis, the paralysis is not progressive Mental defect is present in varying degrees in all cases of spastic paralysis

TREATMENT

The first essential is correction of deformity followed by muscle re-education The re-education consists chiefly of over-developing the antagonistic muscles and establishing co-ordinated movements Assisted movements with stretching of the contracted muscles in plaster-casts and splints should be persisted with in the early stages as the deformity is then due to muscle spasm As the unaffected antagonistic muscles gain strength the contractures will be overcome Care is taken not to operate on muscles and tendons for pure spasm as it is found that deformities due to pure spasm subside after prolonged plaster immobilisation in the correct position and muscle re-education Tenotomies tendon lengthening operations and bone operations *e g* arthrodeses

painful muscle spasm is a condition of "mental alienation" of the antagonistic muscles, leading to paralysis and wasting and muscle inco-ordination

Treatment is aimed at abolishing the "mental alienation" and restoring the peripheral circulation By these means, and by muscle re-education Sister Kenny maintains that paralysis is abolished and deformity prevented The vascular spasm is relieved by the application of hot foments applied to the muscles every two hours or by short wave diathermy being given The feet are supported by a board at the foot of the bed in an attempt to convey the sensation of standing In the apyrexial stage the patient is placed in a warm bath on a canvas stretcher and passive movements given a special re educative technique being used The limb is grasped firmly just below the insertion of the paralysed muscle or muscle group and the patient encouraged to attempt active movement. As the patient focuses his attention on the performance of this, the masseuse passively assists the limb movement. This corrects "mental alienation" Once per day the patient is taken out of bed to stand and so stimulate the proprioceptor mechanisms and to aid re-establishment of the peripheral circulation

Sister Kenny s methods have never been popular in this country and her demonstrations failed to impress leading authorities The methods are not in conformity with the known pathology of the disease but whilst hydrotherapy may alleviate pain and allow one to detect and develop some residual function in the affected muscles, her conception of the pathology of the disease cannot at present be accepted

SPASTIC PARALYSIS (LITTLE'S DISEASE)

Spastic paralysis is a condition of increased tone of certain groups of muscles as a result of a lesion of the central nervous system It is characterised by muscular weakness stiffness, spasm and inco-ordination rather than by true paralysis The muscles with increased tone cause con tractures initially because of spasm and later fixed deformities because of the shortening The affection is due to

form being accompanied by complete motor, sensory and sympathetic paralysis distal to the level of the lesion. Nerve degeneration follows, and the muscles which are supplied by the nerve are paralysed and waste. Electrical stimulation with faradic current (rapidly interrupted current) produces no response, whilst galvanic stimulation (constant current) gives a slow, sluggish contraction. Normally, faradism produces a sustained contraction of a muscle, whilst galvanism produces a single twitch of the muscle at make and break of the current, the contraction being greater at the break of the current. A greater current than is normally required has to be applied to stimulate the muscles, whilst the polar formula is reversed, i.e. greater response at the "make" of the current. These changes in the electrical reactions are known as the "reaction of degeneration". The division of the sympathetic fibres of the nerve causes vasomotor paralysis, thus producing loss of sweating of the skin distal to the lesion, and atrophic changes in the skin and subcutaneous fat. There is anaesthesia over the distribution of the nerve distal to the lesion. Incomplete division gives paralyses of varying degrees, whilst the presence of abnormal sweating suggests an irritation of the damaged nerve.

Treatment.—Any cause of nerve compression must be removed. In cases of injury and where symptoms of complete nerve division are present, exploration should be undertaken early to restore the continuity of the nerve trunk. If there are symptoms of incomplete division, the affected limb is immobilised in such a manner as to prevent stretching of the paralysed muscles, and massage and electrical stimulation of the muscles commenced so that the tone may be preserved until the nerve recovers. The joints acted upon by the affected muscles should be put through a range of passive movements daily to prevent stiffness and adhesions. If there is no improvement within three months, exploration of the nerve is undertaken. After operation the limb is splinted to prevent stretching of the nerve and the paralysed muscles. Muscle re-education, especially by occupational therapy, is a very important means of restoring function.

are only performed for actual contractures and to aid stability They must be regarded purely as an incident in the programme of treatment. For deformities of the arm erasion of the insertion of the pronator teres to the radius is performed for fixed pronation, whilst arthrodesis of the wrist by a tibial bone graft passing from the radius to the third metacarpal is used for persistent flexion deformity of the wrist.

In the region of the hip adductor tenotomy is most frequently required

The foot deformity of equinus needs operative lengthening of the tendo-Achilles, whilst equino-varus or equino valgus, is usually treated by a triple arthrodesis

PERIPHERAL NERVE LESIONS

The peripheral nerves contain motor and sensory fibres and sympathetic nerves, and a lesion of such a nerve will affect all these fibres and their functions These functions may be interfered with by compression or division of a nerve

Nerve compression.—The conducting fibres of a nerve may be pressed upon by increased pressure within the nerve sheath, as in a haemorrhage or when the nerve is inflamed It may also be compressed by pressure from without, such as will occur with the presence of a neuro-fibroma, or other swelling not directly connected with the nerve Compression results in partial interruption of nerve conduction, and the paralysis of motor and sensory function is incomplete Some degree of nerve irritation is often present

Nerve division—Direct violence usually severs a nerve completely at the site of impact and the divided ends may be displaced. Hence suture is required to restore continuity of the nerve When a nerve is stretched excessively the nerve sheath usually remains intact but the nerve fibres are divided In such cases the axons are divided at different levels thus, any operative attempt to suture the fibres is rendered almost impossible

The division may be complete or incomplete, the complete

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LESIONS OF INDIVIDUAL NERVES

1 **Brachial Plexus.**—Lesions of the whole brachial plexus are due to severe neck or shoulder wounds and produce paralysis and anaesthesia of the whole upper limb Partial brachial plexus lesions are more commonly seen as a result of birth injuries They usually follow difficult labours where traction on an arm may be necessary or where the head and neck are forced to one side, as in deep transverse arrest, so stretching the brachial plexus. The lesions are due to physiological division of the nerve fibres A whole arm obstetric palsy is very rare, and two types of partial plexus paralysis are described i.e (*a*) the upper arm or Erb-Duchenne type, and (*b*) the lower arm or Klumpke type



Fig 205 —Erb's palsy splinted with a Cramer wire splint.

(*a*) *The upper arm type* is due to damage to the upper trunk of the brachial plexus, thereby involving the nerve fibres from the fifth and sixth cervical roots of the spinal cord The arm hangs loosely at the side, with the forearm pronated The muscles paralysed are the deltoid supra spinatus biceps coraco-brachialis, and brachialis If untreated contractures of the unaffected muscles develop causing fixed adduction and internal rotation of the arm

Treatment consists in immobilising the baby's arm in abduction and external rotation at the shoulder flexion of the elbow to 90 and supination of the forearm and extension of the wrist, using special splints Cramer wire (Fig 205) or cardboard Recovery occurs in the majority of cases within three to six months Old untreated cases need myotomy and tenotomy of the pectoralis major and subscapularis muscle to correct the muscle contractures After this operation the arm is immobilised in abduction and external rotation in a plaster shoulder spica for four weeks

(b) *The lower arm type* is due to damage to the lower trunk of the brachial plexus which is derived from the seventh cervical and first dorsal nerve roots or is due to damage to the roots themselves There is paralysis of the intrinsic muscles of the hand giving a claw hand deformity with anaesthesia over the inner aspect of the hand and forearm Horner's syndrome i.e constriction of the pupil and exophthalmos may be present suggesting a root lesion The hand should be splinted as for an ulnar paralysis (*vide infra*) but recovery is infrequent

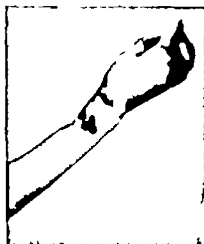


Fig 206 —Median and ulnar nerve paralysis due to gunshot wound of the forearm. Note the thumb is rolled away from the hand while the fingers assume a semi flexed position

2 **The Median Nerve** —This is frequently injured in wounds of the forearm and may be involved in a Volkmann's ischaemic contracture The hand is held in the characteristic attitude of flattening of the palm and fingers, with lateral rolling of the thumb (Fig 206) If the nerve is severed near the wrist the paralysis affects the thenar muscles and the two lateral lumbrical muscles Anaesthesia is present over the thumb and the index middle and radial aspect of the ring fingers If the nerve is affected above this level there is paralysis of the flexor muscles of the thumb and in addition paralysis of the muscles of the index and middle fingers



Fig 207 —Splint for median nerve paralysis

Pain from nerve irritation is common in median nerve lesions and this is often associated with considerable sweating and coldness of the skin of the hand This is known as causalgia

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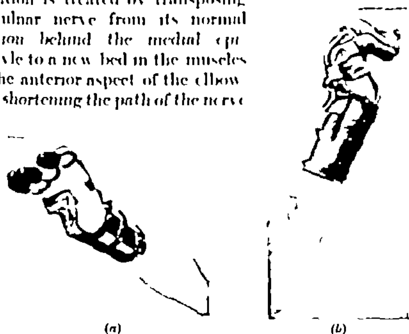
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necessary when these splints are worn for ulnar and median nerve lesions because of their tendency to produce pressure sores

The function of the ulnar nerve may be interrupted by the nerve being stretched following the production of cubitus valgus by mal union of a fracture involving the medial epicondyle of the humerus An additional factor in the production of the paralysis is the development of friction neuritis due to the nerve slipping over the epicondyle The condition is treated by transposing the ulnar nerve from its normal position behind the medial epicondyle to a new bed in the muscles on the anterior aspect of the elbow thus shortening the path of the nerve and eliminating the friction This operation is most conveniently performed with the patient lying prone, with the arm abducted and internally rotated



(a) (b)

Fig 210 (a) and (b) —Splint for radial nerve paralysis Note cock up splint combined with elastic extension straps for the fingers.

4 **The Radial Nerve** is more frequently injured than other nerves It is often injured in fractures of the mid shaft of the humerus, when it may be damaged by the bony fragments or later involved in callus It may be damaged by pressure in the axilla, due to the incorrect use of crutches

The extensors of the wrist and fingers are paralysed causing the characteristic wrist drop Sensory loss is slight and present only when the nerve is injured in the upper one third of the arm

Treatment—Conservative methods involve splinting of the thumb by a special splint in order to prevent over stretching of the opponens pollicis muscle (Fig 207) If operative exploration has been performed the arm should be fixed with the wrist and elbow flexed to avoid tension on the nerve



Fig 208—Bilateral claw hand.

8 **Ulnar Nerve**—The ulnar nerve is injured most commonly in fractures around the elbow joint, especially the medial epicondyle, or in wounds of the ulnar aspect of the forearm If the nerve is injured at the elbow the hand is clawed and radially deviated due to paralysis of the flexor carpi ulnaris ulnar half of flexor digitorum longus and the small muscles of the hand except those of the thenar eminence and medial two lumbricals This is accompanied by anaesthesia over the ulnar half of the hand little finger and ulnar aspect of the ring finger If the lesion is at or below the wrist, the small muscles of the hand, as above, are paralysed and the anaesthesia affects the fingers only (Fig 208)

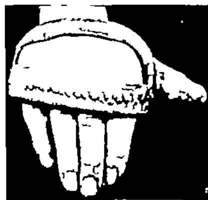




Fig 209—Splint for ulnar nerve paralysis.

Conservative treatment involves the use of a special splint, shaped like a knuckle duster which prevents the hyper-extension of the metacarpo-phalangeal joints (Fig 209) It should be added that considerable care and supervision is

necessary when these splints are worn for ulnar and median nerve lesions because of their tendency to produce pressure sores

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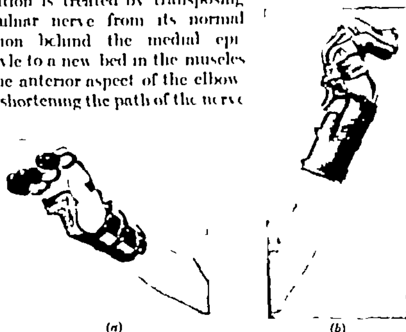


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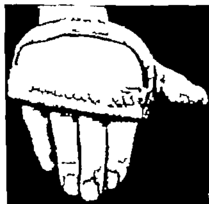
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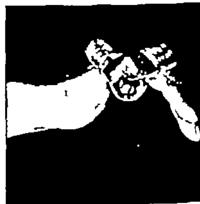
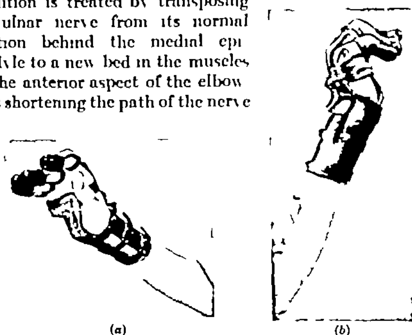


Fig 209 —Splint for ulnar nerve paralysis.

Conservative treatment involves the use of a special splint shaped like a knuckle duster which prevents the hyper-extension of the metacarpo-phalangeal joints (Fig 209) It should be added that considerable care and supervision is

necessary when these splints are worn for ulnar and median nerve lesions because of their tendency to produce pressure sores

The function of the ulnar nerve may be interrupted by the nerve *being stretched following the production of cubitus* valgus by malunion of a fracture involving the medial epicondyle of the humerus An additional factor in the production of the paralysis *is the development of friction* neuritis due to the nerve slipping over the epicondyle The condition is treated by transposing the ulnar nerve from its normal position behind the medial epicondyle to a new bed in the muscles on the anterior aspect of the elbow thus shortening the path of the nerve



(a) (b)

FIG. 210 (a) and (b) —Splint for radial nerve paralysis. Note cock up splint combined with elastic extension straps for the fingers.

and eliminating the friction This operation is most conveniently performed with the patient lying prone, with the arm abducted and internally rotated

4 **The Radial Nerve** is more frequently injured than other nerves It is often injured in fractures of the mid shaft of the humerus when it may be damaged by the bony fragments or later involved in callus It may be damaged by pressure in the axilla due to the incorrect use of crutches

The extensors of the wrist and fingers are paralysed causing the characteristic wrist drop Sensory loss is slight and present only when the nerve is injured *in the upper* one third of the arm

Treatment is along the general lines already discussed, and the prognosis is good The paralysed muscles are protected by a cock up splint, which should not project beyond the distal palmar crease in order to allow full finger movements A useful addition to the cock up splint is the provision of elastic bands to keep the fingers extended (Fig 210) If a large portion of the nerve is lost in the injury suture is often obtained by anterior transposition of the nerve in front of the humerus and flexion of the elbow as this manoeuvre allows the nerve to take a shorter course If irreparably damaged function can be restored by transplantation of some of the wrist flexor muscles into the extensor muscles, followed by intensive muscle re-education

5 **The Circumflex or Axillary Nerve** may be damaged in wounds of the shoulder and following dislocation of the shoulder This results in paralysis of the deltoid and teres minor leading to loss of abduction of the shoulder Conservative measures consist of immobilisation of the shoulder on an abduction frame and physiotherapy to the paralysed muscles

If the nerve is irreparably damaged, the deltoid paralysis is overcome by performing an arthrodesis of the shoulder joint with the arm abducted 60 and flexed 10 The serratus anterior muscle then performs abduction

6 **Serratus Anterior** muscle paralysis may occur following a blow on the shoulder forcing the latter downwards and tearing the nerve supply It results in a winged scapula Irreparable lesions need operation the humeral insertion of the pectoralis major (sternal part) being detached and sutured to the serratus anterior

7 **The Sciatic Nerve** may be injured in deep penetrating wounds of the thigh If the lesion is complete there is paralysis of the muscles below the knee and anaesthesia of the leg below the knee except along the medial aspect of the leg and foot.

8 **The Peroneal Nerve** may be damaged by fractures and wounds of the upper part of the fibula The muscles on the anterior and lateral aspect of the leg are paralysed causing foot-drop and inversion and adduction of the foot. During treatment, side irons, with drop-foot stop or a toe-raising

spring are worn Irreparable lesions may be treated by Naughton Dunn triple arthrodesis or Lambrinudi's drop foot operation

9 **The Tibial Nerve** lesion causes a splay foot with anaesthesia of the sole of the foot Trophic ulceration of the foot is common Overstretching of the muscles can be prevented by wearing a boot with a strengthened tongue or side irons and a stop to prevent dorsi flexion

TUMOURS OF THE PERIPHERAL NERVES

Tumours of the peripheral nerves arise from the fibrous sheaths of the nerves and may be single or multiple They are known as neuro-fibromata and produce symptoms of nerve compression *i.e* paralysis and pain by pressing upon the nerve fibres. Occasionally they undergo degeneration and become cystic They should be treated by excision, carefully preserving the nerve trunk After treatment is directed to aiding recovery of function by splinting the limb to prevent stretching of the paralysed muscles and maintaining their tone with electrical stimulation and massage

Multiple neuro fibromata are a part of a condition known as Von Recklinghausen s disease The tumours are felt in the subcutaneous tissues and along nerve trunks and are associated with skin pigmentation They are only removed if individually causing symptoms, or if they are enlarging rapidly as this symptom suggests malignant change

Treatment is along the general lines already discussed and the prognosis is good The paralysed muscles are protected by a cock up splint, which should not project beyond the distal palmar crease in order to allow full finger movements A useful addition to the cock up splint is the provision of elastic bands to keep the fingers extended (Fig 210) If a large portion of the nerve is lost in the injury, suture is often obtained by anterior transposition of the nerve in front of the humerus and flexion of the elbow as this manoeuvre allows the nerve to take a shorter course If irreparably damaged function can be restored by transplantation of some of the wrist flexor muscles into the extensor muscles, followed by intensive muscle re-education

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furrow The child rarely survives more than a few days if born alive

(e) *Spina bifida occulta*—Here the defect is in the vertebral laminae There is no protrusion of cord or

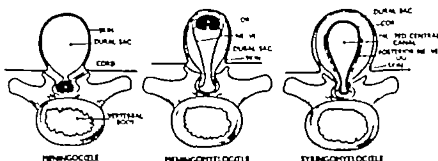


Fig. 211 —Types of spina bifida with cystic subcutaneous tumour

membranes, but the latter are often connected to the skin by fibrous bands A pigmented horny pad of skin often overlies the defect Neurological symptoms such as disorders of micturition trophic ulceration of the feet, and paralyses of the legs may develop later in life because of traction upon the spinal cord by the fibrous band (Figs 211 and 212)



Fig 212 —Lumbo-sacral meningocoele

(f) *Anterior spina bifida*—This is a rare defect where the vertebral body is incomplete and allows anterior protrusion of the contents of the spinal canal

Symptoms—In addition to the spinal defect, there are often paralyses of the legs and bladder paralytic talipes or

CHAPTER XIII

AFFECTIONS OF THE SPINE

ACUTE OSTEOMYELITIS

ACUTE osteomyelitis of the *spine is rare and is usually* pyaemic in origin. Bone destruction resulting from the infection causes collapse of the affected vertebrae. Abscesses may develop and point in similar situations to those due to tuberculosis of the spine. **Treatment** is conservative and consists of immobilisation in a plaster of Paris jacket and recumbency or in a plaster of Paris bed, and the administration of a course of sulphathiazole to combat the infection. Abscesses are opened and drained when discovered.

CONGENITAL MALFORMATIONS

Spina Bifida is a congenital gap in the vertebral column through which the contents of the spinal canal may protrude. The coverings of the spinal cord are usually maldeveloped. Five varieties occur.

(*a*) *Meningocoele*.—This is a saccular dural protrusion through the bony gap in the posterior wall of the vertebral column. It occurs most commonly in the lumbar region, and less commonly in the cervical region. The sac has a narrow neck and contains cerebro-spinal fluid but no nerve tissue.

(*b*) *Myelo-meningocoele* is a dural sac containing the spinal cord and nerve tissue. The bony defect is often considerable.

(*c*) *Syringomyelocoele*.—In this type the spinal cord itself forms the lining of the sac. The skin over it is usually well formed and pigmented.

(*d*) *Myelocoele*.—In this type the closure of the neural canal during development is defective and the furrow present is really lined by the interior of the spinal cord. Cerebro-spinal fluid escapes from the

culosis rickets osteomalacia fractures osteo arthritis and tumours

(*d*) Pathological conditions of the extremities causing an asymmetrical posture

(*e*) Postural or habit scoliosis, due to the assumption of a bad posture There is defective tone in the posterior spinal muscles on one side of the body

Symptoms —Often the only symptom is the presence of an obvious deformity of the spinal column but occasionally there are complaints of backache and tiredness Later in life old standing cases will suffer from severe backache because of osteo arthritis of the inter-vertebral and inter articular joints of the spine

The deformity is associated with elevation of the shoulder and prominence of the chest on the side of the convexity The arm of that side hangs away from the side, and the whole trunk appears to be moved laterally towards the convex side The rotation of the bodies of the vertebrae to the convex side causes the posterior parts of the ribs of that side to be unduly prominent, forming a sharp prominent ridge, often known as a razor back (Fig 218)



Fig 218.—Scoliosis with primary thoraco-lumbar curve convex to the right. Note the elevation of the right shoulder and the prominent right scapula

Treatment —Any pathological lesion of the vertebrae must receive the appropriate treatment. Scoliosis due to pelvic obliquity torticollis, or shortening of one limb is compensatory in type, does not progress, and is not the essential lesion It will be corrected to a large extent by correction of the causal condition

The postural type is usually amenable to conservative treatment in the early stages but, if neglected the contractures of the ligaments and the changes in the bones will inevitably prevent full correction of the deformity Any factors which aid the production of the defective posture,

paraplegia Other deformities such as claw feet, hare lip and hydrocephalus may be present.

Treatment —*Immediate treatment* is only necessary in (*a*) and (*b*) it is not necessary in (*c*) and (*e*), and of no avail for (*d*) It consists of excision of the sac when the child is fit to stand the operation *e g* at 6–9 months It is indicated before this only when there is danger of the skin ulcerating *Later treatment* is necessary for any paralyses along the lines of that for spastic paralysis, and for prevention and correction of deformities

Other congenital defects which are important are spondylolisthesis and sacralisation of the fifth lumbar vertebra They are discussed under ' Low Back Pain '

SCOLIOSIS

Scoliosis is a rotary lateral curvature of the spine The rotation and curvature alter the relative positions of the ribs and pelvis, whilst the ligaments and soft tissues on the concave aspect are contracted and those on the convex side are stretched The deformity interferes with the reflex action of the muscles which retain a normal posture, causing further increase in the deformity The vertebrae become wedge shaped being narrow on the concave side The curve is said to be a right thoraco-lumbar or cervico-dorsal, depending on the site when the convexity of the primary curve is towards the right. Secondary compensatory curves appear above and below the primary curve in order to bring the head and visual axes, and the feet, on parallel planes

Causation —(1) Congenital scoliosis is due to malformation of the spine, scapula, or thorax

(2) Acquired scoliosis may be due to

(*a*) An asymmetry of the body other than in the spine, *e.g* torticollis pelvic obliquity from a short leg or pelvic asymmetry

(*b*) Interference with the soft tissues about the spine and abdominal wall such as occurs in anterior poliomyelitis, spastic paralysis, syringomyelia and following an empyema.

(*c*) Pathological conditions of the vertebrae *e g* tuber

traction with a head halter and skin extension on the limb on a Whitman frame angled at 150 When the curve is corrected as much as possible by these means, a plaster jacket is applied with the patient suspended by the head arms, and legs (Fig 214) The plaster jacket is cut through transversely opposite the point of maximum convexity of the primary curve and hinges and a turnbuckle are fitted Further correction is then gradually applied by the turnbuckle When maximum correction is obtained the two halves of the plaster are rejoined and the hinges and turnbuckle removed (Fig 215) A window is cut over the curvature and a spine fusion operation performed The operation may have to be done in two or three stages to fuse the whole of the primary curve The plaster of Paris jacket is retained for 4–5 months in order to allow consolidation after which a spinal brace is fitted After this has been worn for one year the fusion should be sound enough to hold the spine in the corrected position The brace is then gradually discarded



FIG 215 —Turnbuckle cast for scoliosis The turnbuckle and hinges are applied to the suspension plaster-cast. The latter is then cut into two sections by dividing it along the line indicated on the plaster Further correction is then obtained by separating the sections on the convex side by means of the turnbuckle. When full correction is obtained, the two sections are joined by plaster and the hinges removed

KYPHOSIS

In the foetus the vertebral column has two primary curves convex dorsally—the sacral curve and the curve

such as squint or defective hearing should be remedied. The aim of the orthopaedic treatment is to re-align the head shoulders and pelvis, and to produce a good posture, the actual improvement of the spinal curve being a secondary consideration This re-alignment is obtained by suspending the patient by a head halter and applying a plaster jacket. The body musculature is then developed by remedial exercises particularly for the back and abdominal muscles, so that they will become sufficiently strong to hold the spine in the corrected position and maintain a good posture *Weight stress* must be eliminated at first to allow the muscles to develop this being done by the plaster jacket. It may need to be supplemented by head and leg continuous traction on a Bradford frame. The jacket must include the pelvis and the leg on the convex side, and the neck, if the curvature extends above the seventh or eighth dorsal vertebra This jacket is to prevent further deformity and to maintain the correct position It is bivalved and removed for exercises and passive stretchings and worn continually between the exercise periods until the muscles can hold the corrected position This stage is reached when the standing and recumbent lengths of the thorax are the same, when the posture is maintained actively permanently and without effort and when there is a normal sense of thoracic *equilibrium*

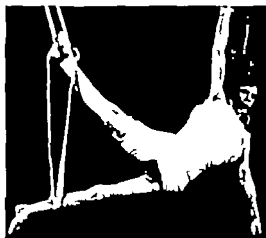


FIG 214 —Suspension by modified Le Mesurier method for initial correction of a structural scoliosis A plaster jacket is applied in this position. The left arm has been cut loose but in suspension for correction this arm was subject to more pull than the other

This method of treatment is unsatisfactory for cases of paralytic origin and old severe postural cases, which advance despite conservative treatment These cases are treated by

with a period of rest in bed Heat and massage are given during this period of recumbency Very severe pain may need a spinal brace to afford relief Lowering of the shoe heels will often relieve the pain by helping to reduce the exaggerated lordosis which is always found with a kyphosis If the condition is limited to one or two vertebrae in young patients and associated with persistent backache a spine fusion operation may be performed

ANKYLOSING SPONDYLITIS

Ankylosing spondylitis is a condition characterised by ossification of the spinal ligaments and ankylosis of large joints It occurs chiefly in young men The disease starts like a rheumatoid arthritis affecting large joints the sacro-iliac and hip joints being most commonly affected first, or as a fibrositis The attack is usually associated with pyrexia and considerable pain Ultimately, the lower spine is affected and becomes stiff and rigid Early changes occur in the inter articular joints thus producing stiffness The anterior and posterior longitudinal ligaments ossify, giving the typical bamboo spine appearance, the spine then being immobile (Fig 216) Recurrent attacks are common with spread of the affection to other joints If untreated the patient has a rigid kyphotic spine with a rigid hyper extended neck (Fig 217) The large joints affected are ankylosed often in bad position

Treatment —Removal of any septic focus does result in improvement in the acute stage, and helps to prevent further spread The patient should be recumbent in a plaster bed with all joints splinted to prevent deformity Active and passive movements are carried out as far as possible without producing pain A course of deep X ray therapy is very valuable in arresting the progress of the disease and relieving pain and all cases should have the benefit of this method of treatment After the acute stage the patient may be allowed up in a brace

When the disease is quiescent, operations to correct deformity and in the case of the hip joint, vitallium cup

extending from the skull to the sacrum. At birth two secondary curves develop these being concave backwards They are associated with the erect posture, and are found in the cervical and lumbar region The curves depend upon the vertebral bodies the intervertebral discs, and the supporting ligaments and muscles Thus, a kyphosis may occur as a result of

(a) bone disease, *e g* in tuberculosis rickets, tumours
(b) intervertebral disc defects
(c) muscle and ligamentous defects

KYPHOSIS IN CHILDREN

Kyphosis in children may be due to

(1) **Postural** type—the common round back Remedial exercises and stretching the back over a pad are usually followed by improvement

More rarely it is due to

(2) **Vertebral epiphysitis.** (See chapter on epiphysitis)

KYPHOSIS IN ADULTS

Kyphosis in adults is usually due to

(1) **Senile osteoporosis of the vertebrae,** due to rarefaction of the vertebral body with expansion of the inter vertebral discs
(2) **Degeneration of the whole intervertebral disc,** with new bone formation at the periphery of the disc—spondylosis deformans This is commonly called osteo-arthritis of the spine
(3) **Senile kyphosis,** due to degeneration of the anterior parts of the discs
(4) **Ankylosing spondylitis**

All four types may be associated with backache and kyphosis

Treatment consists of removal of septic foci together

KUMMELL'S DISEASE

Kümmell's disease is a localised collapse of the vertebral bodies. The affected vertebra collapses and becomes wedge shaped giving an angular kyphosis, and this angulation alters the mechanics of the inter articular joints causing backache.



(b)

FIG. 216A.—X ray photograph of advanced ankylosing spondylitis showing the "bamboo" spine.



FIG. 217.—The end result of untreated ankylosing spondylitis. Note the typical fixed deformity of the dorsal and cervical spine.

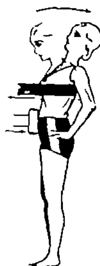


FIG. 218 (After Baker). Hyper-extension exercise to improve posture and reduce deformity of cervico-dorsal spine for ankylosing spondylitis where complete bony ankylosis has not supervened. The sling and buffer prevent movement below the mid-dorsal region.

acetabuloplasty or excision of the head of the femur are performed giving improved function If the spine is not completely ankylosed exercises are undertaken to correct the kyphosis and neck extension For this hyper-extension



(a)

FIG 216 —X ray photograph of advanced ankylosing spondylitis showing the "bamboo" spine

of the lower part of the spine is prevented by using a fixation sling round the thorax and a pressure pad against the abdomen (Fig 218) When correction is obtained, a brace is worn to maintain correction

Treatment depends on the pathological factors causing the pain and may be described as follows

(1) LOW BACK PAIN DUE TO CONGENITAL DEFECTS OF THE LUMBO SACRAL SPINE

(*a*) **Spina bifida occulta** (*vide supra*) Immobilisation in a plaster jacket for three months usually alleviates symptoms

(*b*) **Asymmetry of the articular processes of the fifth lumbar vertebrae** —This causes increased strain and osteo-arthritis and painful muscle spasms develop

(*c*) **Spondylolisthesis** —This is a displacement forwards of the whole spine above the sacrum due to congenital defect in the neural arch of the fifth lumbar vertebra Trauma is usually an exciting factor Backache and stiffness accompany the defect. Treatment aims at reduction of the displacement by traction on the spine with the spine and sacrum flexed and then fixation by a spine fusion operation



Fig 220 —Left unilateral sacralisation of the fifth lumbar vertebra

(*d*) **Sacralisation of the fifth lumbar vertebra** is a condition where the fifth lumbar vertebra tends to acquire *characteristics of the sacrum, and its transverse* processes may articulate or fuse with the sacrum Unilateral sacralisation causes backache and sciatica by leverage exerted on the sacro-iliac joint, leading to strain of the joint (Fig 220) A manipulation of the spine often results in relief of pain Operative excision of the process is undertaken if the pain recurs

(*e*) **Exaggeration of the lumbo-sacral angle** —The spine normally makes an angle of 120° with the axis of the sacrum If this angle is increased there will

There is usually a previous history of injury The collapse is thought to be due to minute cracks in the vertebra or a crush fracture which is unrecognised at the time of the injury Weight bearing then leads to collapse

Treatment —This consists of immobilisation in a plaster of Paris bed for 3–4 months after which the patient is allowed up If pain recurs a spine fusion operation is performed to prevent movement of the joints of the affected vertebra The operation and its after treatment are the same as that referred to in the chapter on tuberculosis of the spine



Fig 219 —Sciatic scoliosis.

LOW BACK PAIN AND SCIATICA

Low back pain and sciatica are common complaints the cause often being very elusive and uncertain The site of the pain is very variable and may be located in one or both sides of the lumbo-sacral region of the back It may or may not, radiate down the posterior or lateral aspects of one or both thighs, this radiation being known as sciatica. The pain of sciatica may be experienced in the heel or behind the knee and this may be associated with numbness and tingling This pain is aggravated by coughing straining or stooping Occasionally there is a history of previous trauma to the lumbar region, and periods of remission of symptoms are often admitted by the patient. On examination, it will be found that the patient cannot fully extend the knee when the hip is flexed without experiencing pain Palpation along the back of the thigh elicits tenderness The deep reflexes are usually present, and muscle wasting is only found in certain lesions producing sciatica If the patient is examined whilst standing a scoliosis can often be detected (Fig 219) the convexity of the curve being towards the same side as the pain in some cases, and on the opposite side in others On walking a limp can be detected due to the hip knee and ankle-joints of the affected leg being held in flexion

of a head suspension plaster Head and leg traction is valuable for severe cases giving considerable relief from pain

(3) PATHOLOGICAL CONDITIONS AFFECTING THE SPINE AND BACK MUSCLES

Tuberculosis acute osteomyelitis spinal cord tumour and neoplasms of the vertebrae produce backache and may produce sciatica when the lumbo sacral region is affected Treatment is directed to the underlying pathology

Fibrositis of the lumbar and gluteal muscles is an extremely common cause of low backache and sciatica, and is due to a chronic inflammatory condition of the ' rheumatic ' type affecting the muscle sheaths and fascia Acute attacks are interspersed with periods of freedom or chronic backache Movements which stretch the affected muscles aggravate the pain, and in the acute attack, the pain is so agonising that movement is impossible due to marked muscle spasm In chronic cases, localised tender thickenings are felt in the affected muscles especially near their origins and insertions There is often an element of chronic toxaemia present, and a search has to be made for focal sepsis if permanent benefit is to follow treatment Any septic focus is eradicated During the acute attack the patient is confined to bed and given a brisk purge Radiant heat and diathermy afford relief and the acute attack subsides within a few days During the chronic stage a manipulation, followed by a course of vigorous deep massage heat therapy and active remedial exercises usually dispose of the condition whilst injection of 2 per cent. novocaine into the tender nodules is a valuable aid to resolution

(4) POSTURAL DEFECTS

Posture is the term applied to the alignment of an individual's head neck, and shoulders, body pelvis and limbs When standing in a correct posture an imaginary plumb-line

be increased strain at the lumbo-sacral joint, and backache often results Treatment consists of rest in bed with the spine, hips and knees flexed, followed by a course of spinal exercises and physiotherapy If pain persists or recurs, a spinal brace is given

(2) TRAUMATIC-CAUSES

(*a*) **Sacro-iliac strain** —The sacro-iliac joint is often strained by lifting heavy weights by extending the spine rather than extending the legs, or subluxation may recur following trauma and parturition. The pain is referred to the posterior spinal muscles over the joint and down the postero-lateral aspects of the thigh It is worse when the patient lies on his back, but is relieved when lying on the side Stooping and flexing the extended leg at the hip causes accentuation of the pain. Muscle spasm is often marked in acute cases, whilst in older cases scoliosis may be present.

Recent strains are treated by rest in bed with the hips and knees flexed over a pillow assisted by radiant heat and massage In old standing cases, adhesions are usually present in the joint, and in these manipulation under anaesthesia followed by remedial exercises, often produces rapid cure. In intractable cases with severe pain arthrodesis of the sacro-iliac joint may be necessary

(*b*) **Lumbo-sacral strain** —Strain of this joint may follow traumatic flexion of the spine Stooping does not increase the pain as in sacro-iliac strain. Relief is afforded by rest in bed, aided by radiant heat and massage After subsidence of the pain, remedial exercises are commenced to try to produce good posture A light brace may be needed until this is obtained

( ) **Ligamentous and muscular sprains** are treated by rest in bed and radiant heat therapy or by application

(b) *The sway back* where the knees are flexed the pelvis tilted upwards to be almost horizontal, a long lumbo thoracic kyphosis and an acutely flexed head Weight is borne on the heels more than normally (Fig 223 (a) (b) and (c)

Treatment.—The patient must be instructed in the elements of correct posture and must be taught to walk with the chest forwards the abdomen drawn in the lower back curve flattened the head up, and the chin drawn back

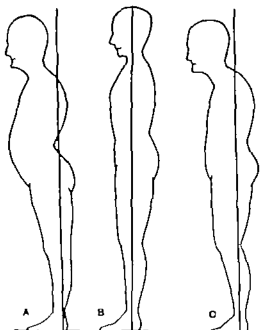


FIG 223 —(A) Forward-Slump (B) Correct Balance (C) Sway Back

wards A thorough course of remedial exercises is given after a period of rest in bed whilst swimming is to be recommended as a therapeutic recreation Excessive weight is corrected by dieting and foot defects are remedied

(5) INTRA PELVIC CAUSES

Low backache and sciatica may be due to **gynaecological conditions and pelvic tumours,** especially prostatic neoplasms The sciatic nerve is then subject to pressure by the neo plasm or its secondary deposits

dropped from the side of the head should pass through the middle of the ear shoulder hip knee, and lateral malleolus

Postural defects are due to muscular imbalance, resulting from defective postural habits during sitting and walking There is also an hereditary basis underlying most postural defects a certain type of posture being inherited like other

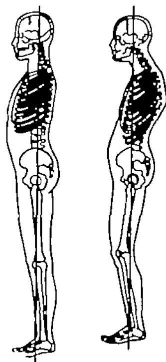


Fig 221 —Good and bad posture, all the antero-posterior curves of the spine are exaggerated

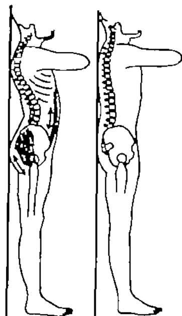


Fig 222. —Flattening the lumbar spine by contraction of the glutei and abdominal muscles, a valuable exercise for correction of posture

characteristics, such as red hair or blue eyes They are often associated with foot defects, especially flat foot.

Improper posture causes undue tension upon joints and their ligaments and excessive work for certain muscle groups and produces fatigue and pain in the joints of the lower limbs and back Figs 221 and 222 (Cochrane)

Common types are

(a) *The forward slump* where the knees are hyper extended, the pelvis tilted forward with lordosis and kyphosis, and carrying forward of the head

the protruded cartilage disc The patient is nursed on his back, and can be allowed up on the twenty first day Occasionally, a spine fusion operation is performed on completion of removal of the disc and the after treatment then consisting of immobilisation in a plaster jacket for three months

A combination of many of these causes may be operating in the production of low backache and sciatica Rest in bed followed by a course of physiotherapy causes relief in a great number of cases Where scoliosis is present because of the muscle spasm immobilisation in a suspension plaster will benefit the patient Congenital defects are rare causes of sciatica, by far the commonest causes being fibrositis of the lumbar and gluteal muscles and prolapsed intervertebral disc

COCCYDYNIA

Coccydynia is the term ascribed to pain in the region of the coccyx It may follow a fall or parturition when the coccygeal joints are damaged and osteo-arthritic changes ensue Many sufferers obtain relief by a course of diathermy and by injection of novocaine into the affected region Intractable cases are treated by excision of the coccyx, and after operation the nurse must be most careful to prevent contamination of the wound with urine and faeces

(6) SPINAL TUMOUR

Intra-spinal tumours are a rare cause of sciatica. They produce symptoms by pressure upon the nerve roots in the spinal theca.

(7) PROTRUSION OF AN INTERVERTEBRAL DISC

Recently it has been found that herniations of the soft nucleus pulposus of the intervertebral disc into the spinal

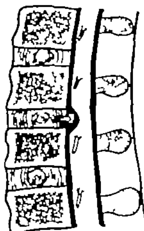


Fig. 224.—Prolapse of an intervertebral disc.

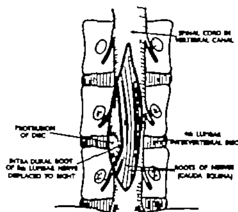


Fig 224a.—Retropulsion of the inter vertebral disc between the fourth and fifth lumbar vertebra, with branches of cauda equina to fifth lumbar root stretched over the prolapsed disc.

canal may cause sciatica and low back pain by friction or pressure on the spinal nerve roots (Figs 224 and 224a.) In diagnosis 25 c c. of cerebro-spinal fluid are removed and replaced by air with the patient lying on his side with the foot of the table raised X rays are then taken the air out lining the protruded disc in the spinal canal After the X rays have been taken the patient must lie with his head low for twelve hours to prevent rapid ascent of the air to the subarachnoid space around the brain as this may cause syncope

Treatment consists of hemi laminectomy and removal of

is taken chiefly by the interlocking of the bones of the foot and by the ligaments and these provide structural stability to the foot In motion the postural action of the supporting muscles stabilises the foot and balances the foot in a position so that the leg is functionally vertical over it This balancing is known as postural stability '

The movements of the foot consist of dorsi flexion plantar-flexion abduction and adduction pronation and supination Dorsi flexion and plantar flexion occur chiefly at the ankle joint whilst the others occur at the sub astragaloid and mid tarsal joints The foot is said to be pronated or everted when it is rotated on its longitudinal axis so that the sole faces outwards Supination or inversion is the reverse movement Adduction is the movement of moving the forefoot medially whilst abduction is the opposite movement Adduction is always combined with some inversion, and abduction with eversion

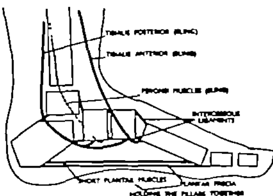


Fig 225 — The supports of the longitudinal arch of the foot.

The gastrocnemii and soleus muscles forming the tendo Achilles perform plantar-flexion whilst the tibialis anterior and peronei and extensors of the toes produce dorsi flexion Adduction and inversion is due to the action of the tibialis posterior and anterior muscles and abduction and eversion is due to the peronei muscles

When considering disorders of the feet the extremities should not be regarded as detached segments of the body but should be viewed in the light of disabilities brought about in other parts of the body by the lesion of the foot, especially in the knee and back At the same time, it should be borne in mind that the foot is heir to all the ills of the remainder of the body and foot symptoms may be the reflection of a general constitutional disorder Paraesthesia of the feet is common in diabetes and pernicious anaemia

CHAPTER XIV

AFFECTIONS OF THE FOOT

THE human foot, during the course of evolution, has become specially adapted for three important *functions*

(1) that of supporting the body weight
(2) that of acting as a lever to raise the body and move it forwards in locomotion
(3) that of acting as a shock absorber for the body during locomotion

To perform these functions efficiently the foot must be mobile and yet sufficiently stable to support the body with a minimum of muscular effort. These conditions are provided by the anatomical arrangement of the small bones of the foot in a series of arches this arrangement being mechanically strong and yet resilient enough to give elasticity in walking The longitudinal series of arches extend from the os calcis along the five metatarsal bones ending in the head of each the weight of the arches decreasing from the medial to the lateral side The anterior transverse metatarsal arch extends between the heads of the metatarsals the summit being the head of the second metatarsal This arch becomes flattened during weight bearing The arches are maintained by the interlocking of the bony articular surfaces by the interosseous ligaments binding the bones together by the muscles and *ligaments of the sole of the foot holding the pillars of the* arches together inferiorly and by support of the tibialis anterior and posterior and peroneus longus brevis muscles. (Fig 225)

When the foot acts as a support, the body weight is transmitted through the ankle-joint to the astragalus, and from this keystone of the longitudinal arches, through the arches to the three weight bearing points of the foot, which are the posterior tuberosity of the os calcis and the heads of the first and fifth metatarsals. When standing the strain

of the support given to the shank The toe should be rounded and the toe-cap should be high enough to avoid pressure on the toes The upper should fit the heel firmly, and the shoe should be firmly held to the foot by a strap or lace up front

The common faults in shoes are in the heel and the sole The heel is usually too high This causes weight to be borne on the articular surface of the head of the metatarsals a function for which they are not designed In addition the toes are dorsi flexed and as a result of this the lumbrical muscles act at a mechanical disadvantage This allows the anterior metatarsal arch to be flattened and the metatarsals splayed out causing metatarsalgia The high heel also causes the foot to slide forwards off the heel into the forepart causing crowding of the toes High heels tend towards instability when walking producing wobble' This calls for extra muscle action to control it and produces fatigue and so predisposes to foot strain The fault of narrow toes causes cramping together of the toes and accentuates any tendency to hallux valgus

DEFECTS OF THE INFANT'S FOOT

The future of the race moves forwards on the feet of little children (Phillip Brooks) The foot of the infant, when it commences to walk at 12–18 months has a cartilaginous structure which is easily moulded by the new stresses applied to it. It is important, therefore that the foot be maintained in a position to withstand these strains and protected from any deforming or abnormal stress.

When a child first starts to walk, he walks with his feet widely apart in an effort to maintain his balance This places strain on the inner sides of the feet and causes them to become flattened and pronated Thus some degree of flat foot is physiological at first but this is soon corrected by the increased power which the leg muscles acquire with the increased exercise of walking However if the child is obese or is suffering from rickets or malnutrition there is a tendency for the pronation to be accentuated because of the general loss of muscle tone and the relative weakness

whilst intermittent lancinating pains may occur as the result of thrombo-angiitis obliterans

FOOTWEAR

Ill fitting shoes are a potent source of foot ailments, especially in the feminine section of the population. This is largely because fashion and style dictate their footwear to the exclusion of anatomical and physiological demands, and no shoe is too small for the foot of the ambitious female Whilst some licence is justified in this respect with dress shoes, the frequency of foot disorder would decline if every day footwear were designed to fit the foot rather than the eye. (Fig 226)

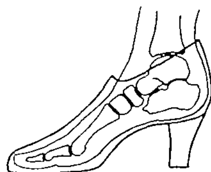


Fig 226.—High heels cause weight to be borne by the articular surfaces of the heads of the metatarsals, resulting in degenerative arthritis.

A good shoe should be long enough to allow for the elongation of the foot which occurs when standing and walking As the foot is often half a size larger when bearing weight, there should be a space equal to the thickness of the finger tip between the big toe and the end of the shoe The bulge of the head of the first metatarsal should rest on the commencement of the curve on the inner side of the shoe, and the shoe must be wide enough to prevent cramping of the toes and yet not so wide as to allow lateral movement of the foot inside the shoe The sole should be flat, straight on the inner side and curved gradually on the outer side It should become narrow enough under the longitudinal arch to allow the upper to fit the foot closely The shank should be rigid and supported on the inner side by the heel, being prolonged forwards along that side The heel should be 1¼–1½ in high for women and ¾–1 in for men It should be broad enough to prevent wobble, and should have straight sides The modern wedge heel is very satisfactory because

flexion then can only be brought about by eversion of the foot and "flat foot" develops The shortened tendon further accentuates the foot defect by producing eversion at the subastragaloid joint Treatment consists of fitting shoes which have a Thomas heel with the inner side of the sole and heel raised 1/8–3/16 in, and the practice of heel stretching exercises (Figs 229 and 230) For the latter

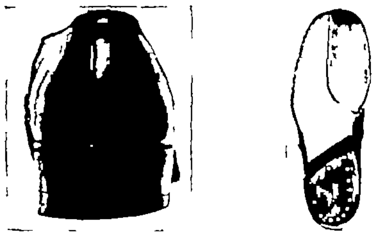


FIG 230 —Thomas heel.

the foot should be inverted and adducted and the knee extended The heel is then forcibly dorsi flexed

FLAT-FOOT IN ADOLESCENTS AND ADULTS

"Flat foot" may result from defects of any of the structures which aid in the preservation of the longitudinal arches of the foot.

Osseous defects may cause "flat foot" The commonest factors producing this are mal united Pott's fractures producing fixed eversion of the foot, or unreduced fractures of the os calcis which produce disappearance of the arches of the foot and eversion of the foot.

Damage to the ligaments of the foot resulting from trauma inflammatory affections, especially gonorrhoeal fasciitis may produce "flat foot."

Paralytic "flat-foot" may occur as a result of anterior

of the leg muscles This interferes with normal foot development, and the arches of the foot fail to appear The condition is corrected by the fitting of shoes with a Thomas heel and by wedging the inner aspect of the heel $\frac{1}{16}$ in This places the foot in the *correct functional position until the leg muscles* regain their normal tone and power Massage may be prescribed as an adjunct to this

Children s shoes should have rigid soles which have a straight medial border with a full rounded toe and no toe cap The counter should fit the heel snugly whilst the upper should fit closely over the instep The shank should be moulded to the arch of the foot, the highest point being

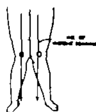


FIG 227 —In genu valgum the weight of the body is borne on the medial aspect of the foot producing flat foot.

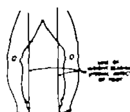


FIG 228 —In genu varum the weight of the body is also borne by the medial aspect of the foot with similar effects.

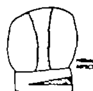


FIG 229 —Wedging of the shoe heel is split open and a leather wedge, $\frac{1}{16}$ in. thick at the widest part, is inserted and the heel then closed.

under the anterior part of the os calcis so as to prevent pronation of the foot The heel should project farther forwards on the inner side than on the outer side so as to afford further support to the shank.

Knock knee and bow legs produce pronation of the child s foot because the body weight is borne chiefly on the inner side of the foot in these conditions whilst torsion of the tibia causing the foot to appear turned inwards or outwards, produces flat foot as a result of this same factor (Figs 227 and 228)

In some children the tendo Achilles is slightly contracted or the muscles forming the tendo Achilles may be overactive This prevents full dorsi flexion of the ankle such as would occur in walking when the body weight is being transferred from the heel to the forefoot The dorsi

from normal is the loss of postural stability, due to the loss of tone of the postural muscles of the foot and leg This allows pronation of the foot and strain is thrown on its ligaments Continued weight bearing with the foot in this position causes relaxation of the ligaments and unlocking of the articulations of the tarsal bones thus causing loss of structural stability and complete relaxation of the foot and collapse of the arch mechanism Abduction of the forefoot is superadded to the pronation defect, and if these abnormal conditions persist arthritic changes occur in the tarsal joints Painful adhesions then develop, but if treatment is still deferred, the foot becomes extremely rigid and often relatively painless if the subject does not indulge in excessive walking

Symptoms—In the early stages of the development of the condition the patient complains of aching tiredness and swelling of the feet The pain may be experienced in the calf of the leg because of the strain imposed on these muscles and under the scaphoid bone and astragalo-scaphoid joint The pronation of the foot causes the line of weight bearing to be moved medially and increased strain is put on the medial side of the knee A further sequel of the flat foot is an increase of the forward tilt of the pelvis which produces a lordosis of the lumbar spine with a concomitant backache Hence the necessity for a complete examination of the patient who complains of the backache

On examination the foot is seen to be rolled downwards and the longitudinal arch flattened so that weight is borne on the whole foot instead of the normal three points (Fig 281 (*a*) and (*b*)) The internal malleolus and scaphoid bones are unduly prominent, due to eversion of the foot, and if the heels are examined, outward rotation of the os calcis will be noted The deformity can be voluntarily corrected in the early stages, but later this can only be performed manually When the foot becomes rigid no such correction is possible

Treatment.—The aims of treatment are

(1) to correct the eversion and abduction of the foot and outward and downward rolling of the os calcis so

poliomyelitis affecting the muscles supporting the longitudinal arches The foot assumes a position of equino-valgus or calcaneo valgus, and is not a true flat foot. Spastic paralysis produces similar deformities

STATIC FLAT FOOT"

Static flat foot is the name given to the common foot disability which is due to disordered function of the foot, and which has been present for some time prior to the onset of symptoms It is particularly liable to occur after an illness, when the general muscle tone is poor or following excessive fatigue of the leg muscles as may occur following exercise which the subject is unaccustomed to perform regularly Occupations which entail prolonged standing cause strain of the ligaments and muscles of the foot, and lead to unlocking of the articulations of the tarsus and the development of a pronated foot. Obesity will accentuate these factors. A painful corn or callosity will often produce flat foot by reflexly inhibiting the postural muscles of the leg and foot. Varicose veins by causing defective nutrition of the muscles and ligaments of the foot and oedema of the ligaments lead to a relaxation of the ligaments and pronation of the foot. Hallux valgus by depriving the inner side of the foot of the support of the big toe predisposes to eversion of the foot and flattening of the longitudinal arch, and a congenital short first metatarsal produces the same effect for the same reason

As in infants a shortened tendo Achilles rotates the foot into pronation and causes weight bearing to be taken chiefly by the forefoot, whilst knock knee and bow legs alter the line of weight bearing so that increased weight is borne on the inner side of the foot. High heeled shoes especially if the counter fits badly, will predispose to flat foot by allowing the foot to slide downwards into the fore-part of the shoe, thus cramping the toes and preventing any movement of the toes and forefoot.

In the development of flat foot the first deviation

under the anterior part of the os calcis and sustentaculum tali of the os calcis in order to prevent the downward and outward rolling of this bone and not under the scaphoid bone which is the highest part of the normal longitudinal arch The support should be $\frac{1}{4}$ in thick on its medial aspect tapering off completely on the lateral side and extending from just posterior to the head of the second metatarsal to the posterior aspect of the heel The width of the anterior edge should be the distance between the lateral side of the first metatarsal to the medial aspect of the fifth metatarsal These distances should be measured by calipers It should be $\frac{3}{16}$ in thick anteriorly *and raised in the centre* to conform to the anterior metatarsal arch It should be bevelled so that the elevation commences on the lateral aspect of the first metatarsal and ends on the medial side of the fifth metatarsal but if there is a congenital short first *metatarsal*, the medial part of the anterior part of the support should not be bevelled as above but should be $\frac{1}{8}$–$\frac{3}{16}$ in thick and extended forwards under the head of the metatarsal so that this metatarsal resumes its normal function of being one of the three weight bearing points of the foot. (Fig 282) If this *support is not sufficient to correct the pronation* the heel and sole of the shoe should be raised $\frac{1}{8}$–$\frac{3}{16}$ in on the inner side to obtain correct foot balance When this is necessary a metatarsal wedge of leather $\frac{1}{8}$–$\frac{3}{16}$ in thick should be placed on the outer side of the sole or inside of the shoe just beneath the head of the fifth metatarsal bone to prevent lateral sliding of the foot

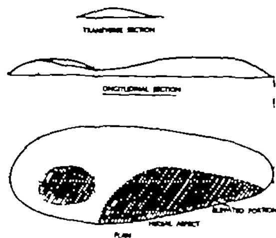


Fig 282.—Arch support for flat foot. (After Diveley)

When commencing treatment many early cases benefit by preliminary rest in bed for 10–14 days so that any oedema

that the line of weight bearing is returned to the normal position and so that the foot is returned to its normal balance

(2) to elevate the longitudinal arch and hold the foot in the position of correct structural stability until the postural muscles and ligaments recover their tone sufficiently to maintain postural stability

(3) to restore the tone of these muscles and ligaments

The first two aims are secured by the provision of correct footwear adjusted to balance the foot for correct weight


(a)


(b)

FIG 231 —Bilateral flat foot Note the marked eversion and abduction of the left foot Note the valgus deformity (pronation) of the heels.

bearing and the provision of felt or rubber arch supports A Thomas heel should be fitted to the shoe It is important to bear in mind that the chief function of arch supports is not that of holding up the arch but that of preventing the downward and outward rolling of the os calcis and forefoot which is the prelude to the collapse of the longitudinal arch Arch supports are not a confession of failure of conservative treatment, as used to be thought arch supports which are often ordered are designed to hold up the fallen arch, and these are based on wrong fundamental principles and are useless as a means of correcting the deformity With this type of support, weight is still borne by the whole of the sole of the foot.

The correct arch support should have its highest point

in full adduction and inversion The patient is allowed up 3–4 days after the manipulation when the reaction has subsided and walking in the plaster is encouraged After four weeks the plasters are bivalved, and removed for exercises and physiotherapy only When the muscle tone of the invertors is sufficiently improved that they can prevent eversion the plasters are discarded and correct shoes and arch supports fitted as for static flat foot

CLAW-FOOT

Claw foot is a deformity where the longitudinal arch of the foot is increased in height and associated with clawing of the toes. It may be acquired or be congenital in origin

Acquired claw foot may result from infantile paralysis or from contractures of the soft tissues resulting from burns and inflammatory conditions It may be found associated with progressive diseases of the central nervous system, such as Friedrich s ataxia and certain muscular dystrophies



Fig 283.—Bilateral claw feet in twins.

The *congenital* or *idiopathic* type is the common type, but despite the description of congenital claw foot, it is rare for the established condition to be evident before the child is seven or eight years of age The longitudinal arch is higher than normal the toes clawed and the forefoot dropped The plantar fascia is taut and contracted The dropping of the forefoot limits dorsiflexion of the ankle and simulates shortening of the tendo-Achilles (Fig 283) With advancing years, true shortening of the tendon does occur and the forefoot becomes adducted Apart from the appearance of the deformity the chief complaints are painful callosities under

may subside If the foot is painful because of adhesions or rigid the foot should be first mobilised by manipulation under general anaesthesia The footwear should be corrected and felt or rubber arch supports of the type described, fitted In most cases they can be discarded when the postural muscles can adequately stabilise the foot in the correct position.

All these measures are supplemented by intensive physiotherapy Contrast and faradic foot baths are valuable aids to the recovery of the tone of the intrinsic muscles of the foot. Exercises to aid these consist of picking up handkerchiefs and marbles with the toes Further exercises are those designed to stretch the tendo-Achilles, walking on the outer sides of the feet, and exercises to strengthen the invertors of the feet. Ballet-dancing is an excellent therapeutic exercise for children

Advanced cases, and certain types of adolescent flat foot, often fail to recover under conservative treatment, and in selected cases operative measures are used. If no arthritis is present, the operation consists of lengthening the tendo-Achilles and arthrodesing the scaphoid-cuneiform joint or astragalo-scaphoid joint with full correction of the flat foot After operation the foot is immobilised in plaster for 10–12 weeks In old rigid cases where conservative measures fail, a triple arthrodesis is performed

SPASMODIC FLAT-FOOT

Spasmodic flat foot is a condition of eversion and abduction of the foot, usually bilateral, which occurs in adolescents and is associated with considerable rigidity of the foot and contraction of the evertor muscles (the peronei) Manual correction of the foot is usually impossible. The feet are painful, and walking is difficult. Often some septic focus is present, and its removal is often followed by improvement of foot condition Many cases show evidence of mid tarsal arthritis, which is often the aetiological factor producing the deformity

Treatment consists of manipulation of the feet under general anaesthesia followed by immobilisation of the feet

in full adduction and inversion The patient is allowed up 3–4 days after the manipulation when the reaction has subsided and walking in the plaster is encouraged After four weeks the plasters are bivalved and removed for exercises and physiotherapy only When the muscle tone of the invertors is sufficiently improved that they can prevent eversion the plasters are discarded and correct shoes and arch supports fitted as for static flat foot.

CLAW-FOOT

Claw foot is a deformity where the longitudinal arch of the foot is increased in height and associated with clawing of the toes It may be acquired or be congenital in origin

Acquired claw foot may result from infantile paralysis, or from contractures of the soft tissues resulting from burns and inflammatory conditions It may be found associated with progressive diseases of the central nervous system such as Friedrich s ataxia and certain muscular dystrophies



FIG 288 —Bilateral claw feet in twins.

The *congenital* or *idiopathic* type is the common type but despite the description of congenital claw foot, it is rare for the established condition to be evident before the child is seven or eight years of age. The longitudinal arch is higher than normal the toes clawed and the forefoot dropped The plantar fascia is taut and contracted The dropping of the forefoot limits dorsi flexion of the ankle and simulates shortening of the tendo Achilles (Fig 288) With advancing years true shortening of the tendon does occur and the fore foot becomes adducted Apart from the appearance of the deformity the chief complaints are painful callosities under

the heads of the metatarsals and over the dorsal aspects of the clawed toes due to abnormal pressure and friction by the shoes Pain is often experienced in the calf of the legs and in the back due to increased lordosis

Treatment.—The aim of conservative treatment is to raise the forefoot and redistribute the stress of weight bearing from the heads of the metatarsals to the whole foot This can be provided by a metatarsal bar placed posterior to the metatarsal heads and a leather wedge $\frac{1}{8}$–$\frac{3}{16}$ in high beneath the head of the fifth metatarsal to prevent lateral sliding and to redistribute the weight of the body from the lateral side of the foot to the line of the second metatarsal. A felt arch support, with its highest point under the scaphoid is useful for redistributing the body weight strain over a larger area of the foot (Figs 284 and 285)

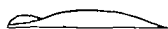


Fig 284 —Arch support for claw foot. (After Dickey)

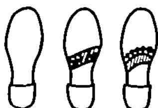


Fig 285 —Metatarsal bars.

These measures should be accompanied by physiotherapy designed to stretch the tendo-Achilles and improve the function of the lumbrical and interossei and muscles of the foot.

Operative measures are usually necessary to supplement the conservative measures The tight plantar fascia and muscles are relaxed by stripping their attachments from the os calcis (Steindler's operation) through medial and lateral incisions along the heel, and manipulating the foot so that they acquire new origins more anteriorly This allows the forefoot to be raised and the cavus deformity is corrected during weight bearing The foot is immobilised in plaster for four weeks after operation and then mobilisation exercises commenced The operation is not very useful for adults when the deformity is fixed, and will not correct after operation

In many cases the chief disability is the clawing of the toes This is well corrected by arthrodesis of the interphalangeal joints of the toes (Lambrinudi s operation) which also compensates for weakness of the interossei The foot

is immobilised on special sandals (Fig 230) or by the insertion of Kirschner wires until fusion is complete

Lengthening of the tendo Achilles is rarely performed, as the tendon is only apparently shortened and lengthening will produce a calcaneo valgus deformity In old standing cases, a triple arthrodesis of the foot may be performed removing wedges of bone dorsally to correct the cavus defect

DEVELOPMENTAL DEFECTS OF THE METATARSALS

The metatarsals normally have their long axes approximately parallel with the first metatarsal, this being longer and broader than the others Occasionally the head of the



FIG 230.—Stamm sandals—used for fixation after toe fusion operations.

first metatarsal is abducted from the second and the head of the *second metatarsal replaces that of the first as one of* the three principal weight bearing points of the foot A similar effect results from the presence of a congenital short first metatarsal bone and from excessive mobility of the first metatarsal and an increased strain is put on the second metatarsal a function for which it is not designed These defects are predisposing factors in the production of metatarsalgia march fracture Freiburg s infraction and pronated feet

HALLUX VALGUS

Hallux valgus is a deformity of the great toe whereby the phalanges of the toe are adducted towards the second

toe. (Fig 237) The head of the first metatarsal is abducted, and the combined deformity causes prominence of the head of the metatarsal on the medial side of the foot. Friction and pressure of the shoes at this point causes a bursa to develop and this, together with the prominent bone, is known as a bunion. Continued trauma often results in a septic infection of the bursa. The deformity is often associated with flat foot, as the loss of the support of the big toe allows pronation of the foot to occur Once the deformity is present, it is accentuated by the pull of the deviated extensor hallucis longus tendon The medial part of the metatarsal head becomes exposed to trauma and osteo-arthritis of the metatarso-phalangeal joint ensues. This together with the bunion is the cause of the pain associated with the deformity



Fig. 237 —Hallux valgus.

Treatment.—Operative treatment is usually recommended It should be delayed until all evidence of sepsis of the bunion is absent. For young patients, and for cases with no arthritic changes excision of the bunion and exostosis is performed, together with transference of the origin of the adductor hallucis muscle from the proximal phalanx to the head of the first metatarsal (McBride's operation) For other cases the proximal half of the proximal phalanx and bunion are excised and an arthroplasty performed (*Fig 238*) *After the operation*, the toe is immobilised for fourteen days in plaster or with a figure-of-eight bandage, with traction exerted on the toe to separate the surfaces of the false joint. When this immobilisation is removed a course of exercises is commenced to correct the pronation

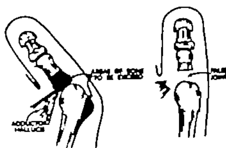


Fig 238 —Operation for hallux valgus. The removal of the bases of the proximal phalanx removes the deforming influence of the adductor hallucis and also produces an arthroplasty

of the foot and to mobilise the toe Correct shoes should be advised for all cases

For patients where operation is contra indicated for reasons of age or other bodily ailments or for those who refuse operation, some relief may be afforded by fitting proper shoes wedged on the inner side as for flat foot, and fitted with a fore part which should be in one piece and have no toe-cap A small felt pad ½ in thick should be placed under the head of the first metatarsal to distribute the strain of weight bearing correctly whilst a metatarsal bar will be invaluable if osteo-arthritic changes are present

Devices devised to hold the toe in the correct position are useless, as they do not relieve symptoms nor do they cure the deformity

METATARSALGIA

Metatarsalgia is the term used to describe pain beneath the heads of the metatarsals It may be due to traumatic or inflammatory conditions of the metatarso-phalangeal joints and adjacent soft tissues It may also be due to static causes, and this may be one of two types (a) relaxation metatarsalgia and (b) the neuritic type of metatarsalgia

The relaxation type usually follows a debilitating illness when the general muscle tone is poor The foot is relaxed and the anterior metatarsal arch depressed resulting in splaying out of the metatarsal heads The stretching of the transverse metatarsal ligaments causes a burning pain which is relieved by lateral compression of the metatarsals

Relief is obtained by strapping the forefoot with zinc oxide strapping so as to prevent the metatarsals splaying out, and by placing a dome of felt ½ in. high beneath the second metatarsal head to restore the anterior metatarsal arch A metatarsal bar is fitted to the shoe to redistribute the area of weight bearing The associated flat foot needs treatment along the lines already described foot exercises and contrast baths being valuable aids to recovery

The neuritic type is often due to lateral compression of the metatarsals by defective footwear the compression of the

toe. (Fig 237) The head of the first metatarsal is abducted and the combined deformity causes prominence of the head of the metatarsal on the medial side of the foot. Friction and pressure of the shoes at this point causes a bursa to develop and this, together with the prominent bone is known as a bunion. Continued trauma often results in a septic infection of the bursa The deformity is often associated with flat foot, as the loss of the support of the big toe allows pronation of the foot to occur Once the deformity is present, it is accentuated by the pull of the deviated extensor hallucis longus tendon The medial part of the metatarsal head becomes exposed to trauma and osteo-arthritis of the metatarso-phalangeal joint ensues. This together with the bunion, is the cause of the pain associated with the deformity



Fig. 237 —Hallux valgus.

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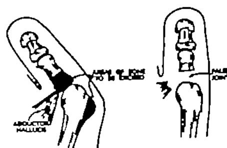


Fig 238 —Operation for hallux valgus. The removal of the bases of the proximal phalanx removes the deforming influence of the adductor hallucis and also produces an arthroplasty

of the foot and to mobilise the toe Correct shoes should be advised for all cases

For patients where operation is contra indicated for reasons of age or other bodily ailments or for those who refuse operation some relief may be afforded by fitting proper shoes wedged on the inner side as for flat foot and fitted with a fore part which should be in one piece and have no toe-cap A small felt pad ¼ in thick should be placed under the head of the first metatarsal to distribute the strain of weight bearing correctly, whilst a metatarsal bar will be invaluable if osteo-arthritic changes are present

Devices devised to hold the toe in the correct position are useless as they do not relieve symptoms nor do they cure the deformity

METATARSALGIA

Metatarsalgia is the term used to describe pain beneath the heads of the metatarsals It may be due to traumatic or inflammatory conditions of the metatarso phalangeal joints and adjacent soft tissues It may also be due to static causes and thus may be one of two types (*a*) relaxation metatarsalgia, and (*b*) the neuritic type of metatarsalgia

The relaxation type usually follows a debilitating illness when the general muscle tone is poor The foot is relaxed and the anterior metatarsal arch depressed resulting in splaying out of the metatarsal heads The stretching of the transverse metatarsal ligaments causes a burning pain which is relieved by lateral compression of the metatarsals

Relief is obtained by strapping the forefoot with zinc oxide strapping so as to prevent the metatarsals splaying out, and by placing a dome of felt ¼ in high beneath the second metatarsal head to restore the anterior metatarsal arch A metatarsal bar is fitted to the shoe to redistribute the area of weight bearing The associated flat foot needs treatment along the lines already described foot exercises and contrast baths being valuable aids to recovery

The neuritic type is often due to lateral compression of the metatarsals by defective footwear the compression of the

digital nerves producing a burning pain which radiates into the toes The fourth toe is chiefly affected, the disability being known as Morton's toe. The cause in this case is invariably a neuroma of the digital nerve, and resection of this gives prompt relief

FREIBURG'S INFRACTION OF THE SECOND METATARSAL

Freiburg's infraction is a condition of the second metatarsal, which results in pain and stiffness at the metatarso-phalangeal joint associated with clawing of the toe. The head of the bone becomes broadened, flattened and rarefied, whilst the shaft of the bone is thickened. This is seen when an X ray examination of the foot is made The condition is thought to be due to overloading of the second metatarsal because of metatarsus varus or a congenital short first metatarsal.

Treatment consists of restoring the point of weight bearing in the forefoot to the first metatarsal by placing a felt pad ¼ in. thick beneath the first metatarsal and by fitting a metatarsal bar If the pain persists the head of the metatarsal is excised.

MARCH FRACTURE

A march fracture is the name ascribed to the condition of spontaneous fracture of the neck of the second or third metatarsal, and is most commonly found in soldiers and those who have to indulge in more foot exercise than they are normally accustomed. Often a congenital short first metatarsal is present, which causes more strain to be put on the second metatarsal This, however is not an invariable finding The patient complains of pain and swelling over the dorsum of the forefoot, and localised tenderness is present over the affected bone An X ray examination reveals a transverse fracture of the neck of the metatarsal in good position and associated with a cuff of callus.

Treatment consists of immobilisation of the foot in plaster for six weeks, followed by treatment of the factors predisposing to the associated foot strain

HALLUX RIGIDUS

Hallux rigidus is a condition of stiffness and limited extension of the metatarso phalangeal joint of the great toe due to osteo arthritis of the joint It may result from trauma, such as striking the end of the toe against a hard object and so injuring the joint articular surfaces More frequently it is a sequel of flat foot, where the toe becomes flexed and with the metatarsal becoming more horizontal the dorsal part of the articular surface of the head is almost non articular and degenerates, leading to osteo-arthritis of the whole joint At first dorsi flexion is limited and painful but as the condition advances, the toe cannot be extended and the patient experiences pain when weight is put on the forefoot. Walking is then only possible if the foot is externally rotated. Relief is afforded by fitting correct shoes with a rigid sole and a metatarsal bar so that no strain is put on the affected joint.

A manipulation will increase the range of movement and relieve pain in recent cases, but advanced cases need operation. This consists of making an arthroplasty by excising the base of the proximal phalanx as for hallux valgus After operation, physiotherapy is directed to the associated flat foot.

HAMMER-TOE

Hammer-toe is a deformity of the toes usually the second, consisting of dorsi flexion of the proximal phalanx with acute plantar flexion of the second phalanx, and plantar flexion or dorsi flexion of the distal phalanx. (Fig 230) The dorsi flexion of the proximal phalanx causes the dorsum of the toe to rub against the shoe, and a painful callosity or corn develops. A corn often develops on the tip of the distal

phalanx The deformity is commonly associated with claw foot and hallux valgus and is usually bilateral.



Fig 239 —Hammer toe

In children the toe should be subject to repeated manipulation and the deformity corrected by strapping passing over and under the toe *In adults* the deformity is fixed and operative measures are necessary (Fig 240) These consist in excising the corn or callosity and the proximal interphalangeal joint with wedges of bone, followed by arthrodesis of the toe The toe is then immobilised for six weeks by a toe splint or a

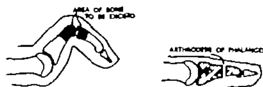


Fig 240 —Operative treatment of hammer toe

Kirschner wire threaded through the phalanges. (Fig 241)

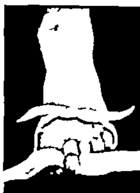


Fig 241 —After operation the toe may be immobilised by bandages and a small metal support. Two bandages are applied. The proximal bandage passes over the dorsum of the toe to prevent hyper-extension of the proximal phalanx. The distal bandage passes under the distal phalanges to prevent flexion These bandages maintain the phalanges in correct alignment.

AFFECTIONS OF THE HEEL

Pain over the posterior aspect of the heel may be due to tenosynovitis of the tendo Achilles or to bursitis external or deep to the tendo-Achilles **Tenosynovitis** is treated by immobilisation in a plaster cast, including the foot and knee, in order to rest the gastrocnemius completely This is retained for three weeks

Bursitis is treated by first relieving pressure on the bursa and the application of heat. Persistence or recurrence of symptoms indicates excision of the bursa.

Epiphysitis of the os calcis is discussed in Chapter X

Calcaneal Spurs —Calcaneal spurs are outgrowths of bone

on the plantar aspect of the os calcis at the origin of the plantar fascia Almost invariably they result from plantar fasciitis often gonococcal in origin, or associated with other focal sepsis Occasionally, a bursa covers the spur and bursitis develops increasing the pain and disability The patient complains of pain in the heel when walking

Treatment is directed to elimination of the focal sepsis and the relief of pressure on the spur by the provision of a sponge rubber inlay in the shoe heel over the site of the spur, or a rubber bar ¼ in thick just anterior to the tender point The plantar fasciitis is treated by application of heat via medical diathermy or short wave diathermy, and vaccine injections Excision of the spur is only performed as a last resort

AFFECTIONS OF THE SKIN OF THE FOOT

CORNS AND CALLOSITIES

A callosity is a localised thickening of the skin which is due to friction and abnormal pressure over areas unaccustomed to such pressure They are associated with claw foot (under the metatarsal heads and over the dorsal aspect of the clawed toe) with hammer toe, and with ill fitting shoes

Where the pressure is exerted over a bony prominence which can exert counter pressure a localised proliferation of the skin arises which also burrows deep into the deeper layers of the skin. This constitutes a corn

Treatment is directed to the aetiological factor producing the painful skin defects and to reducing the callosities or removing the corns Local application of a paint containing Ext Canabis Indica and 30 grains of salicylic acid dissolved in ether and collodion, followed by sodium bicarbonate foot baths, will aid removal of the horny thickenings Curettage or paring with a razor is often necessary for complete removal

Temporary relief from pain may be afforded by the application of felt rings over the corn or callosities, thereby relieving pressure on the painful area

PLANTAR WARTS

Plantar warts are painful localised circumscribed growths in the skin of the sole and heel of the foot They are treated by curettage with a Volkmann spoon followed by the application of 10 per cent silver nitrate to the remaining depression If the warts are multiple application of superficial X rays is the best method of treatment

INGROWING TOE-NAIL

Ingrowing toe-nail is a very painful affection associated with a low grade infection of the nail fold It usually follows



Fig 242. Wedge-excision of nail bed for ingrowing toe-nail

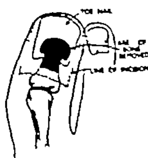




Fig 243 —Radical cure for ingrowing toe-nail

the wearing of badly designed shoes and is precipitated by cutting the nails convexly instead of transversely

In mild cases relief is afforded by packing the nail away from the nail fold with cotton wool soaked in 10 per cent silver nitrate and by correcting sources of pressure and irritation of the nail fold

In well-established cases operative treatment is necessary A conservative operation is the excision of a wedge of skin and nail so as to include the nail fold the raw area being sutured (Fig 242)

For recurrent cases the nail bed may be excised and a skin graft applied or the nail bed excised by amputating the distal half of the distal phalanx (Fig 243) This is a permanent cure which the long suffering patient welcomes

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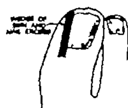
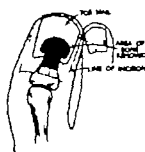


Fig. 242 — Wedge excision of nail bed for ingrowing toe nail.



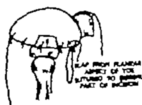


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